SAE JOURNAL

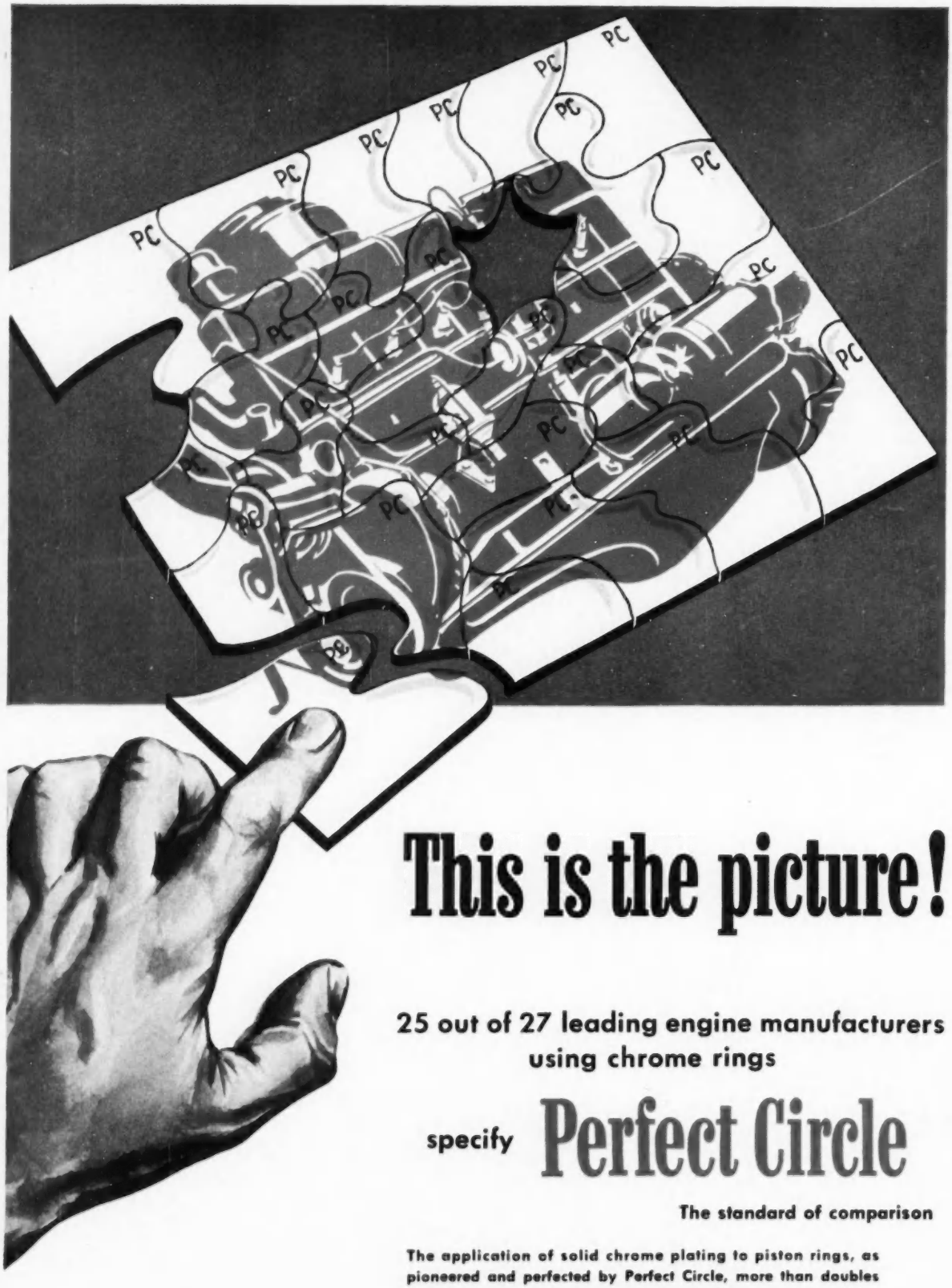


SEPTEMBER
1953

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PUBLISHED BY THE SOCIETY OF AUTOMOTIVE ENGINEERS



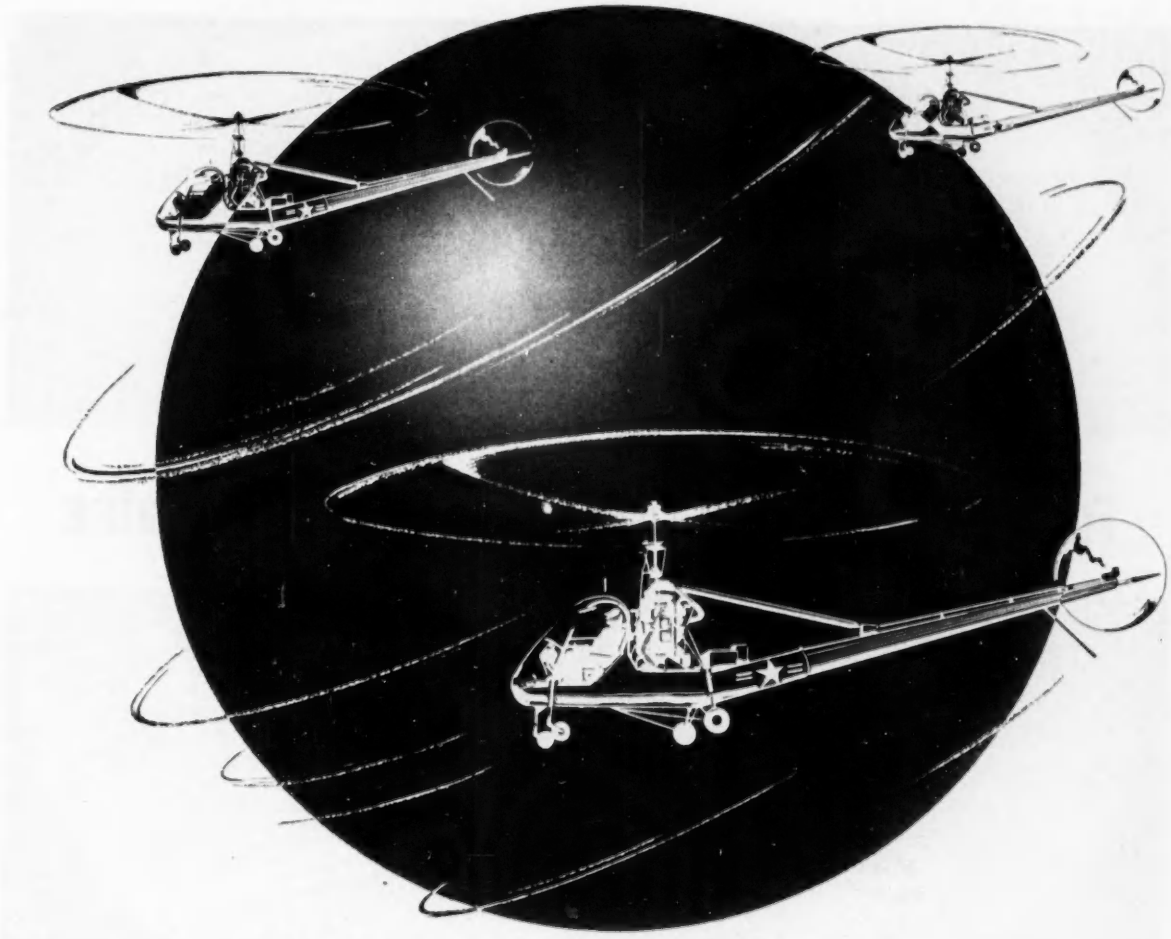
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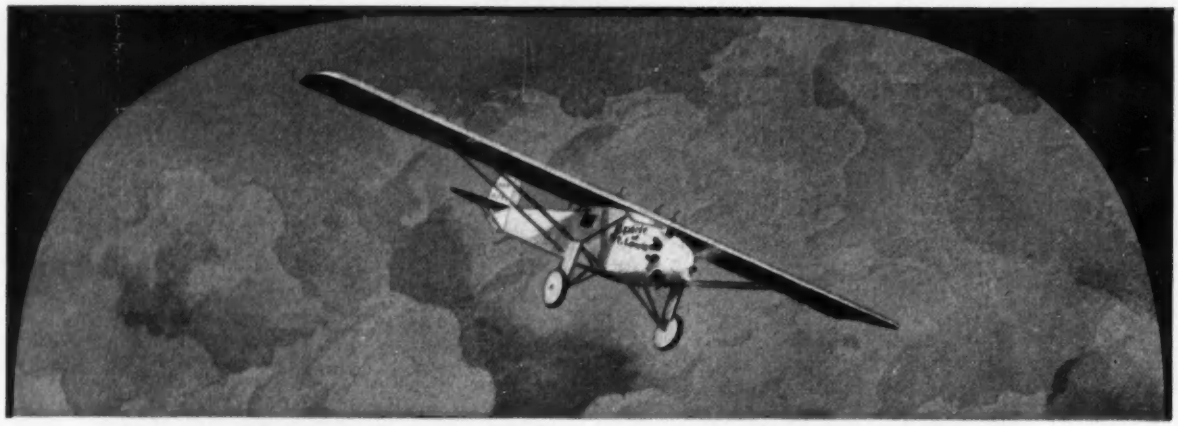


Main transmission of the Hiller helicopter uses New Departure bearings in the clutch assembly.



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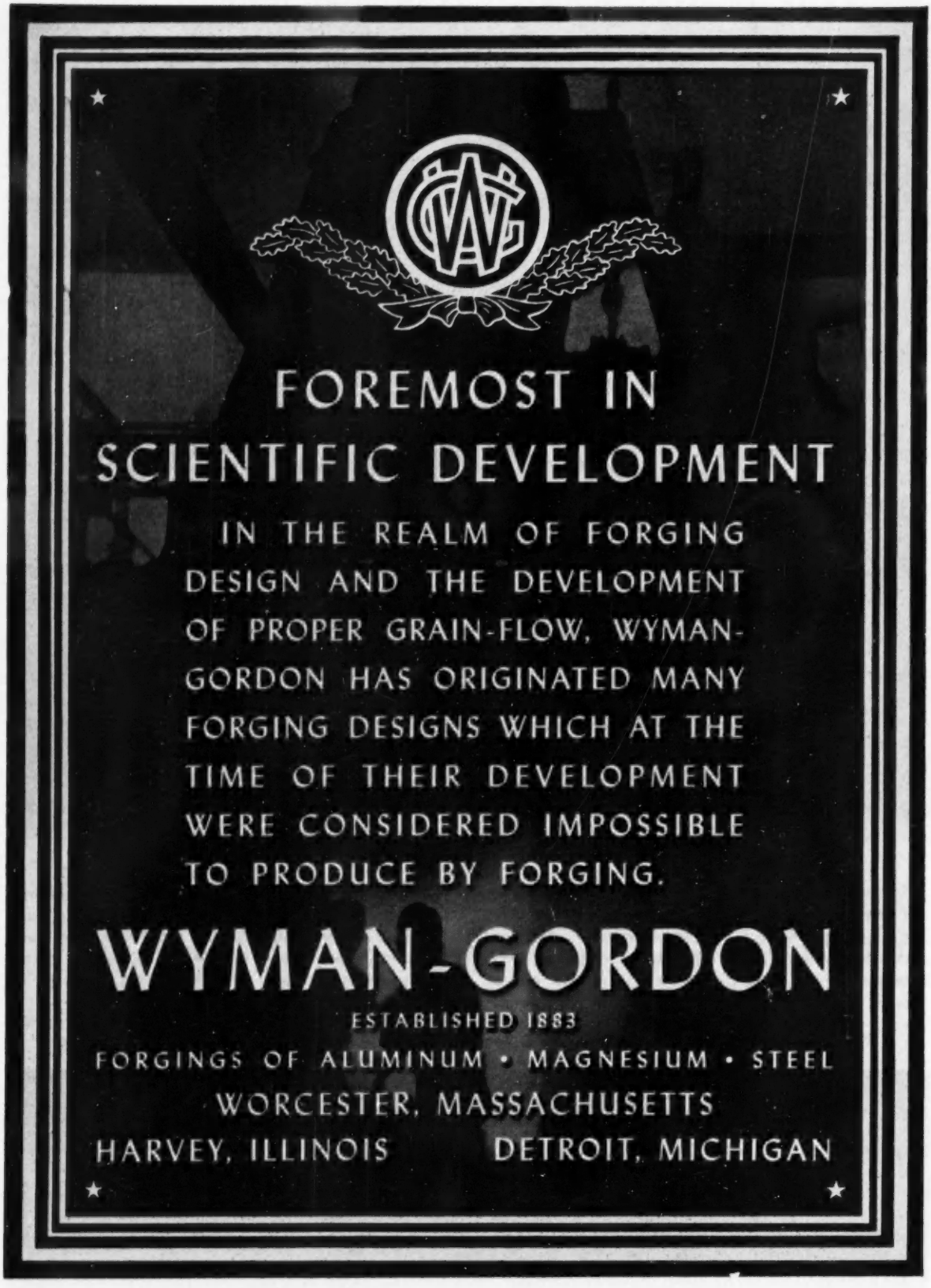
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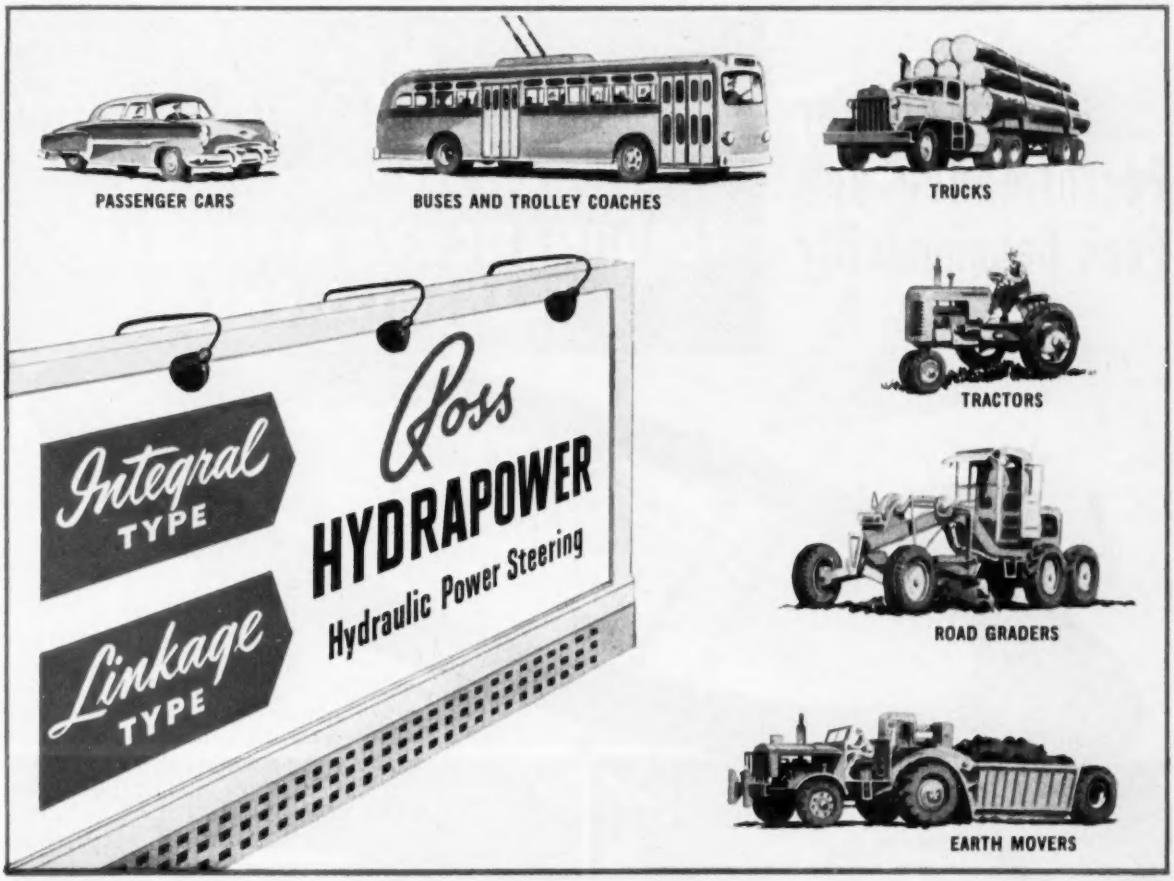
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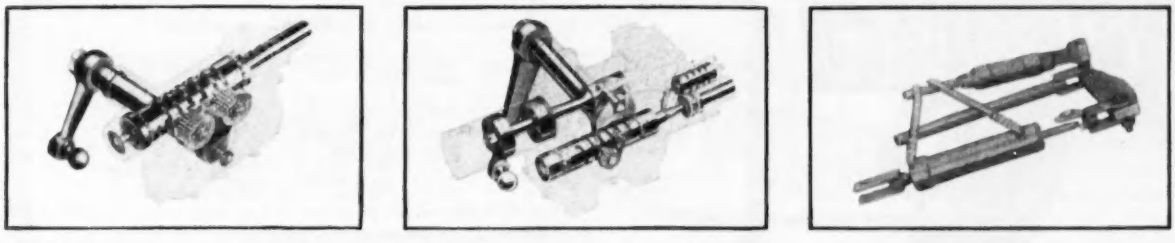
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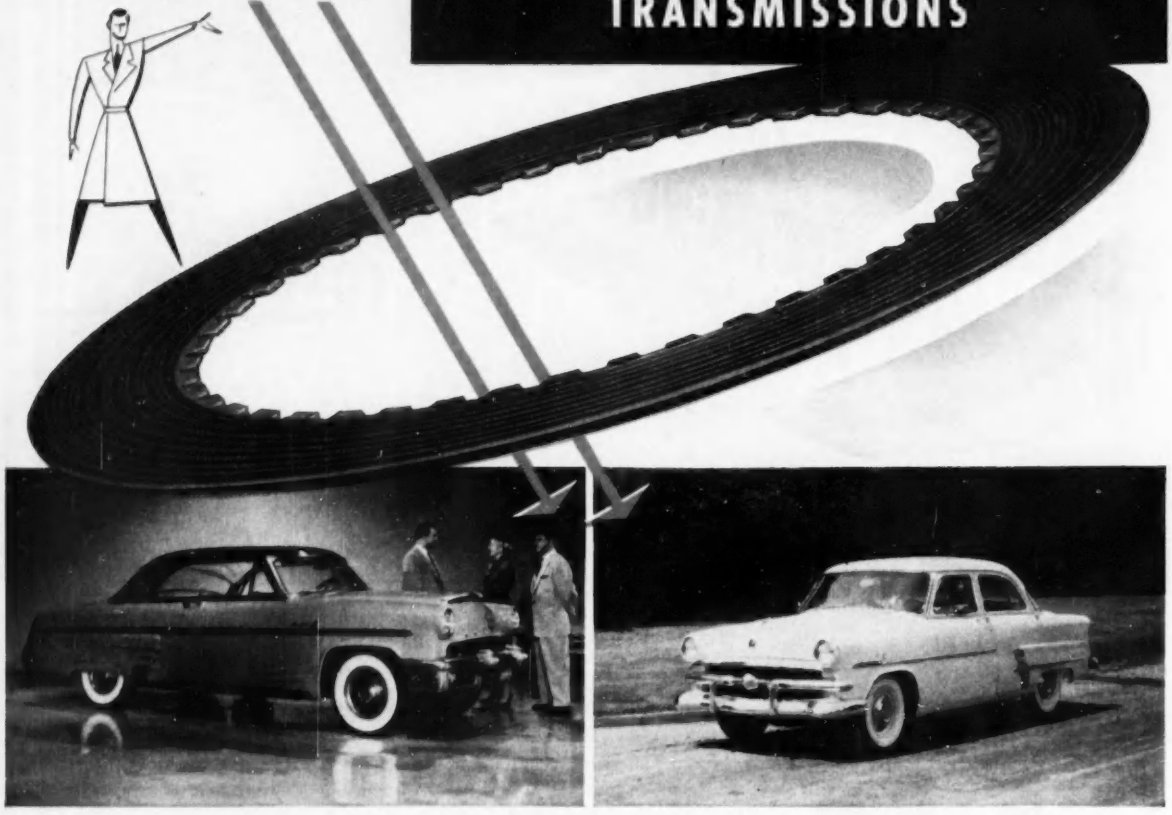
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Fuel, oil, water, air and oxygen all find dependable, safe, uninterrupted flow through Chiksan aero-hydraulic swivel joints and assemblies.

The Flow of Enterprise Relies on

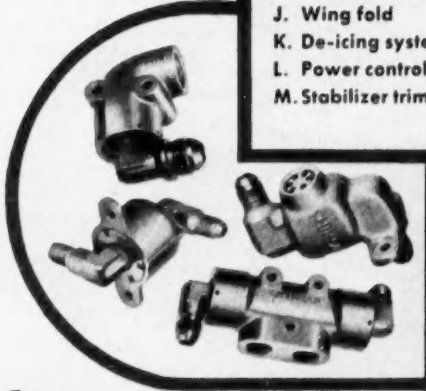
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- B. Steering control mechanism
- C. Brake system
- D. Spoiler actuating mechanism
- E. Fuel and oil lines
- F. Adjustable sweep-back system
- G. Emergency dump chute
- H. Flap actuating system
- I. Power-plant fuel and oil lines
- J. Wing fold
- K. De-icing system
- L. Power control system
- M. Stabilizer trim



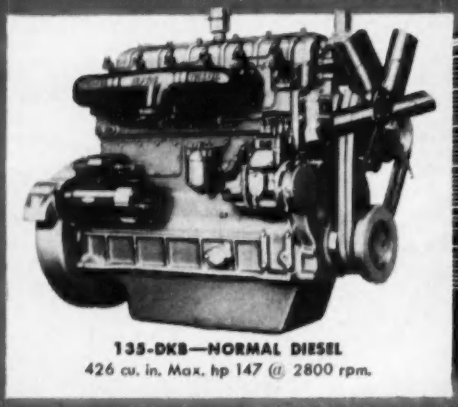
A few of the many Chiksan aero-hydraulic swivel joints made for pressures ranging from 1000 to 3000 psi.

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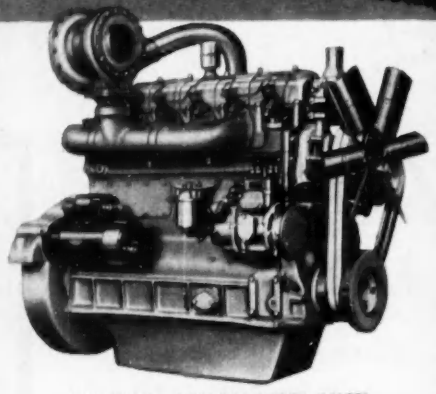
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135-DKB—NORMAL DIESEL
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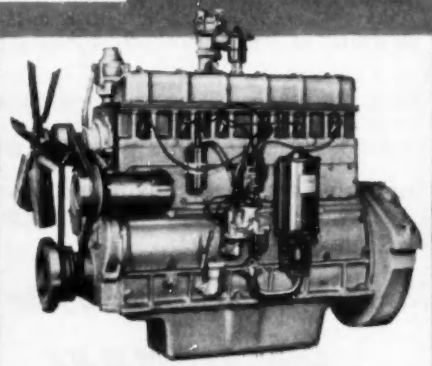
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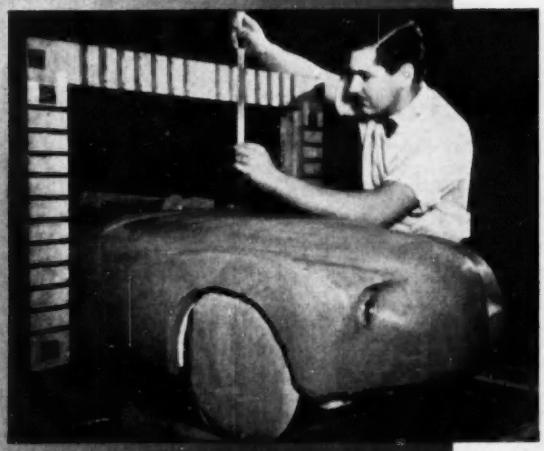




135-GKB and 135-GZB—GASOLINE
426 and 451 cu. in. Max. hp 147 and 153 @ 2800 rpm.

214

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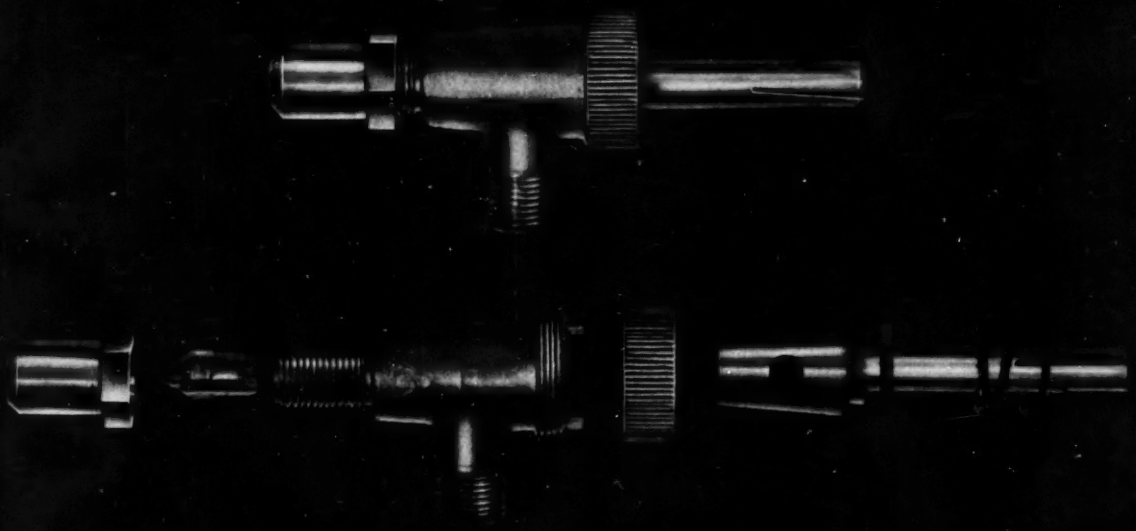
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For the Sake of Argument

Humility . . .

By Norman G. Shidle

"Your editorials are much stronger, much better reading, when the subject matter is presented as an experience you are sharing with your readers. When you feel too sure of yourself, the net effect is didactic."

So wrote a discerning friend recently, commenting on "For the Sake of Argument." A fine writer as well as friend, he went on to make suggestions pertinent to all of us who think or speak or write. Like this:

"Conclusiveness may leave the impression that the author (or the speaker or the conversationalist) has closed his mind with the concluding sentence. If *his* mind is not open, why should the reader open his? . . . And if there are no open minds, there are no human contacts—and no warmth. If this be true, then certainly one should so write as to leave the freedom to accept or reject. Not having all the answers, one can be tolerant of other viewpoints.

"Open-minded writing (or speaking) strikes me as supremely important in this age of propaganda. We are pounded on all sides—not for the purpose of enlightenment, but for blind acceptance. It manifests complete lack of faith in the good judgment of our fellow men. . . . If one has anything of value for another, won't that value be recognized if presented with sympathy and charity—and with full awareness that we are all strangers in a world we cannot fully comprehend?

"You speak of humility as an ingredient as essential as wisdom. I would hazard that one cannot gain wisdom without humility and that the truly wise man is always humble.

"We discuss the art of writing as if it were a bag of tricks—which neither of us believes. Both of us know full well that we cannot dissemble. What we are comes out.

"Yet there is a two-way action. The discipline of writing can lead to discoveries about the self; discipline of the self can lead to discoveries about our work. There is no basic conflict."

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29 West 39th St.
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E. L. Carroll
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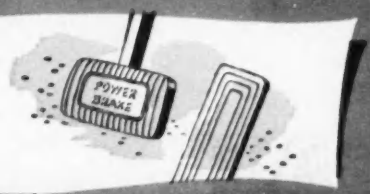
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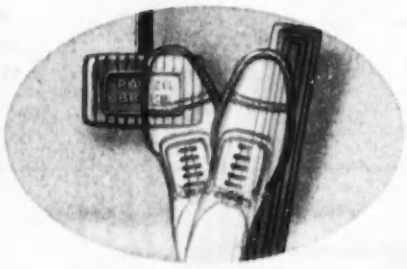
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Nobody Benefits from Truck

NOBODY benefits from the raft of nonuniform vehicle size and weight regulations existing today, especially John Q. Public! That's because this inconsistent flock of do's and don'ts shackle both vehicle designers and fleet operators . . . and this increases the end cost the public has to pay for its transported goods.

Equitable size and weight legislation is that which fosters the most efficient use of the combination of the vehicle and the highway, to the end that the public will receive the maximum return on its investment in highways and bridges through convenience, celerity, and economy of transportation!

Where would marine transportation be, for example, if years ago the U. S. Engineer Department, to avoid dredging of deeper and wider canals, had set a limit of 14 ft of draft, 30 ft of beam, and 200 ft of length?

Where would railroad transportation be if, for the preservation of trackage and bridge structures existing at the end of the Civil War, wheel loads had been restricted to the capacity of 40-lb rails, locomotive weights to 100,000 lb, and speed to 35 mph?

How far could aviation have gotten if airport runways were restricted to 1500 ft, wing loading per sq ft to what it was in 1918, wheel loads to what could be safely supported on a cow pasture?

There is no question that the cost per ton-mile of moving a load is inversely proportional to the amount of load carried. Two 5-ton loads will cost more to move a given distance in a given time than one 10-ton load. This is as true on the highways as it is on the rails, on the sea or in the air. It is therefore in the public interest that highway vehicles of the largest practicable capacity for which loads can consistently be found, be generally employed. But economical operation does not depend on the vehicle alone. The highway is an essential part of the economic equation.

No doubt there is a point at which increase in vehicle capacity would cease to be economical. At the same time, there is a limit to the highway load capacity that it would be economical to build. However, there is a point where the maximum economy of the road and the vehicle on it will provide the lowest overall cost per ton-mile to move the public's goods. It is where these two curves intersect. (See Fig. 1.) Whether consciously or not, it is this optimum which our various states seek to attain in their motor vehicle size and weight laws.

Perhaps the prime reasons why these regulations have failed to benefit the public are that they seem to have as their objects:

1. Preservation of a highway system which is inadequate because of short-sighted planning, political promotion, and 10 years of neglect during and following World War II.

2. Singling out a scapegoat—the heavy truck—for the failures of politicians.

3. Handicapping motor transport for the benefit of the railroads.

Good Roads Pay for Themselves

But the salvation of our declining highway system is not in hobbling highway hauling. Rather it is in building and maintaining roads adequate for the economic demands of modern transportation.

Good roads pay for themselves. Better proof of this can hardly be found than in the record of the wholly self-sustaining Pennsylvania Turnpike,

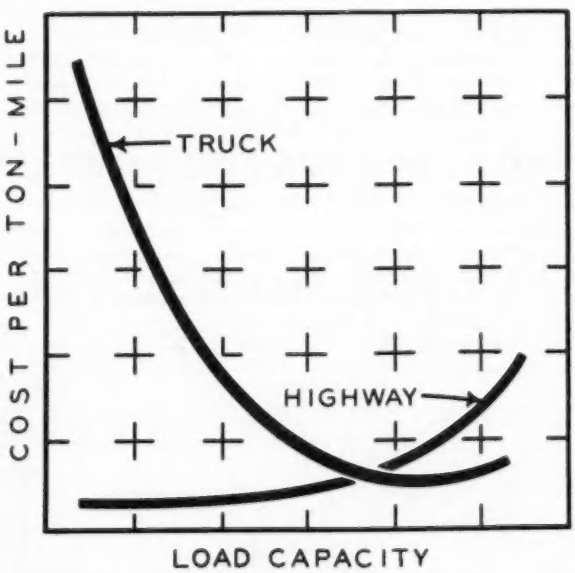


Fig. 1—Further increase in vehicle capacity and highway load capacity ceases to be economical at the point where these respective curves cross each other. This point will provide the lowest overall cost per ton-mile to move the public's goods

Size and Weight Limits!

BASED ON PAPER BY

Merrill C. Horine, Mack Manufacturing Corp.

Paper "Does the Public Benefit from Size and Weight Restrictions?" was presented at SAE Summer Meeting, Atlantic City, June 9, 1953.

whose chief source of revenue is the heavy trucks, whose operators find that the economies realized from its use more than justify the tolls which they pay. This in spite of the fact that they also pay heavy special taxes for the support of public roads which in many cases are inadequate for their use.

We have been told that axle loading beyond 18,000 lb will break down many existing pavements. Yet even the much-touted Maryland road test failed to support the contention that 18,000 lb is the safe limit. Subjected to the equivalent of 10 years of normal service in a few months—and with axle loads far beyond the 18,000-lb figure—this stretch of highway continues to be capable of carrying the traffic which flows over it.

True, it developed cracks where it had been improperly constructed. But these cracks have not destroyed or even seriously impaired the serviceability of the road.

So, in spite of specious assertions to the contrary, *the Maryland road test instead of validating the 18,000-lb axle limit actually invalidated it.*

We are met with the further generality that building roads capable of sustaining greater weight concentrations will involve higher cost . . . for the benefit of only a minority of trucks.

Well, let's look at this matter of cost. Any additional cost to sustain greater axle loads would be confined to the pavement itself. Such things as right-of-way, grading, compaction, preparation of the sub-base, center-striping, guard rails, sign-posting, and drainage would not be affected at all. That's because larger vehicles do not require greater road widths or easier turns. For that matter, at the prevailing volume and speed of passenger-car traffic, safety demands more lane width and curve easing than truck traffic needs. What's more, the larger the capacity of the average truck, the fewer trucks are required to move a given volume of freight . . . and the less traffic room they require.

The greatest fallacy of all, however, is the premise that the extra cost involved in building adequate roads would benefit only owners of the minority of trucks having heavier axle loads.

While it's true that heavier trucks are in the minority, these big fellows are the ones that make the major contribution to the broad transportation picture. They are the ones which haul the people's goods at the lowest unit cost. They are the ones which render an indispensible service in the development of our natural resources and the vast movement of live stock, farm produce, milk, and general freight.

No Need for Bogie Weight Limits

Individual axle weight limits are not the only restrictions affecting the gross weight of vehicles, however. Wholly without justification, thirty states restrict axle weights to figures below 18,000 lb when axles are placed adjacent to each other, as in truck bogies and trailer tandems.

Years ago, the Bureau of Public Roads conducted some tests in which it was determined that where axles were spaced closer than 40 in. apart, the sum of their weights imposed stresses in the pavement greater than either axle would by itself. Conversely, of course, these tests also established the fact that if axles were spaced 40 in. or more, the pavement suffered no more stress than from a single axle. In other words, a bogie loaded to 18,000 lb per axle or a total of 36,000 lb exerted no more stress on the pavement than a single axle imposing 18,000 lb pavement loading. That's where the 40-in. figure, so prominent in many state regulations, comes from.

Tires capable of sustaining 18,000-lb axle loads, however, according to Tire & Rim Association standards, are 11.00-20 or larger. Such tires when new have an overall diameter of approximately 42½ in. and require at least 6 in. of clearance between them. This makes 48½ in. the closest spacing practicable. Indeed for proper skid-chain clearance, 50 in. is the minimum. Thus, there is really no significance in the 40-in. figure . . . and no justification whatever for any limitation on bogie or tandem loads other than individual axle weight limits.

Bridge Formula Is Unnecessary Shackle

Another prevalent weight limitation—the bridge formula—deals with tandem-axle loading from a different standpoint.

On a highway, it makes no difference how axles are spaced provided they are not less than 40 in. apart. On a bridge, however, we are concerned with the total weight imposed between supports of a span. Obviously, the further axles are apart, the less the concentration of weight.

Some years ago, bridge engineers began to worry about these weight concentrations, and they devised a formula intended to limit them. This formula

is $C \times (L + 40)$, in which C is an arbitrary number of pounds, based upon the class of bridge to be protected; and L is the length, in feet, from the center of the first axle to the center of the last axle of the vehicle or any combination of vehicles. The constant C varies from 650 to 850, depending on individual states. Two states make this little pastime more interesting by substituting other constants for the mysterious 40. Ohio uses 47½ and Wisconsin 26, with a C of 1000.

Prof. John S. Worley, of the University of Michigan, in a paper presented at the 1948 SAE Summer Meeting, pointed out some significant facts concerning this formula. He said:

"The design of the standard commercial vehicle is such, as a rule, that no two single axles or groups of axles are closer than 12 ft. Therefore, bridge spans of 24 ft and less can never have a gross load of more than that of a set of dual axles. Bridges with spans of 100 ft or more are largely designed for the dead load—the weight of the bridge structure. The stresses in these long spans are increased but little by additional live loads, due to the fact that the ratio of the live load to that of the dead load is very small. So we see that bridges with spans less than 30 ft and more than 100 ft in length are little affected by an increase in gross loads as long as the axle loads are not increased."

"The critical bridges in our highway system are found in the range of spans between 30 and 100 ft in length. Of these, the numbers are relatively small."

"A continuous procession of vehicles with maximum gross loads is seldom found on a bridge . . . still extremely remote is the possibility of two such processions of maximum loads being on a bridge at the same time, the normal loads for which bridges are designed."

"Conservative ultimate strength of materials, modified by factors of safety ranging from 200 to 400% are used. Occasional overloads of 50% can be carried without causing undue overstress."

Obviously, from a practical standpoint, therefore, there is no need whatever to superimpose the bridge formula on the axle weight limitation. That so many states have chosen to do so indicates the alarming failure to recognize that bridge and highway are essentially one.

The contention that bridges require weight limitations independent of those applying to the road itself is a clear admission that the load capacities of some bridges differ from those of the roads connecting them. Thus, one or the other is either deficient or over-built. And this is a waste of taxpayers' money!

As though this dual basis of limitation were not enough, forty-three states also have a definite ceiling on gross weight, regardless of the other two bases.

Size Restrictions Among the Worst

So much for weight restrictions. There are other restrictions, such as height, which at the moment is not onerous; weight per inch of tire width, a carry-over from solid tire days which has no present-day significance; number of units in a combination, which is of minor importance; and a host of other regulations not concerned with size and weight.

Limitations on width and length are worth some very close scrutiny. Only three states permit more than 96 in. of width, while the allowable length of single units ranges from 35 ft in thirty-six states to as much as 55 ft in Maryland. Only eleven states permit six-wheelers greater length than four-wheelers. Similarly, tractor-semitrailer length limits vary from 45 ft in twenty-one states to 65 ft in Arizona and New Mexico. Length of other combinations remains at 45 ft in thirteen states and ranges up to 65 ft in Arizona, Idaho, and New Mexico. Five states prohibit other combinations.

If all states had identical limitations, each manufacturer could adapt his design in this manner and provide users with the maximum capacity possible under the law. Such uniformity is very far from existing and *it is to be hoped it will not come to pass in the foreseeable future.* This is because the circumstances with respect to soils, terrestrial conformation, road and bridge development, and traffic conditions differ widely in various sections of our country.

A greater measure of uniformity and consistency between the regulations of states within regional groups would not only benefit users of motor vehicles but the public as well.

Not All Restrictions Are Evil

Of course, all governmental regulations and restrictions are not necessarily evil. Many of the legal requirements and limitations are sound and beneficial. This is especially true of those which promote safety of operation, prevent genuine abuse of highways and other public structures, protect the public health, facilitate free flow of traffic, restrict uneconomic wild-cat competition with legitimate carriers, and assure responsible service to shippers at fair rates.

In so far as these enactments and orders have stimulated engineers to creative thinking and challenged their ingenuity, they have been of some general benefit to the profession. Out of efforts to meet these challenges have come developments of advantage in themselves.

Strict axle weight limitations have spurred designers to develop means of increasing the proportion of weight on front axles. This has led to greater compactness of front-end construction, improvements in steering, greater fifth-wheel kingpin offset, and great improvements in COE arrangements. These, in turn, have brought benefits of their own.

Similarly, close enforcement of axle weight limitations has resulted in a great increase in the use of tandem axles for trucks, tractors, and trailers. And this rise in volume of production has implemented many improvements in vehicle design.

Even higher taxes have had beneficial effects. Economic compulsion has accelerated improvements in the fuel economy of engines, and design of more scientific ranges and intervals of gear ratios in transmission and driving axles.

Doubtless all of these things would have come about in response to the competitive urge of a free market. But it is certain that their natural evolu-

tion would have been along sounder lines than has sometimes been the case.

Certainly strict limitation on gross weight has spurred the efforts of engineers to reduce the tare weight of chassis, trailers, bodies, and so forth. However, this has impelled some producers of vehicles to go to extremes to bring down their chassis weights—some body and trailer builders to do likewise. And just as too much shortening can spoil a cake, so it can also prove deleterious to truck design.

What's Needed Are Consistent Laws

And so we come back to the question which is the title of this paper: Does the public benefit from size and weight restrictions? The answer is that *it does not*. Another question might be asked: Could it? Some restrictions no doubt are necessary in the public interest. But greater consistency in them would mitigate some of the harm they now do. If simplified and based on logic and fact, many of their present defects would disappear.

In short, truck producers and operators do not ask for freedom to destroy the roads. They ask merely that they be permitted to put upon them vehicles which will insure the greatest public benefit from their operation; which will not only preserve them as physical assets, but insure the greatest long-run return from the sums expended on them.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

Excerpts from Discussion

Lewis C. Kibbee,

American Trucking Associations, Inc.

• Our hodgepodge of state laws are to a large extent lacking in either scientific or economic fact. This situation is rapidly changing, however.

• In all fairness to the much maligned legislator, put yourself in his position for a moment. He is trying to deal with a complex matter which is only one of hundreds of subjects that come before him. From the welter of ideas proposed, he is asked to come up with a scientific and economic weight law. . . . Almost every session of every state legislature has some truck bills introduced, and from this constant work comes gradual progress.

• We should provide highways which can carry the largest loads which can be consistently found. This definition of load limits is perhaps difficult to arrive at. But I am certainly unimpressed by highway planners who make "loadometer" studies of traffic in states with an 18,000-lb axle load limit, then report only one-half of 1% of the trucks on that road have axle loads over 18,000 lb. . . . It should be evident that . . . we will find commerce generally taking advantage of the highest axle load allowed.

• The demand for heavier axle loading is already here, let there be no mistake about that. Now the question becomes, how much more would it cost to provide a highway facility to carry X times 1000 lb than it would to provide one to carry 18,000 lb? Much research is going on at this time in an attempt to find the answer to this question, but as yet we have not arrived at a solution.

• The author has given us a very enlightening discussion of the evils of the bridge formula, but he has not touched on one aspect of it. The American Association of State Highway Officials Code—upon which many state laws are modeled—does not say that the load-carrying allowance of a vehicle combination is based upon the length in feet between the first and last axle of the vehicle or combination. Rather the carrying allowance is based upon the wheelbase of *any* group of axles in the combination.

• The trucking industry most certainly goes along with the desire to protect our highway system. When looking at the taxes an over-the-road trucker pays each year, it is easy to see that after a few years he has a greater investment in the highway than in his rolling stock. Why shouldn't he be interested in highways?

Hoy Stevens,

Bureau of Public Roads

• In the abstract and as a whole, size and weight limitations have been of benefit to the public. Specific size and weight limitations may not accomplish all of the aims which the author has outlined, but these limitations are the ones which are in error, not the principle.

• The building of highways is an engineering art, as is the building of trucks. Neither are exact sciences, since neither group of engineers has all the facts concerning all the variables which may enter into their respective designs. You automotive engineers are aware of some of the terrific flops which have occurred in truck designs, and which have compelled redesigning. The same thing has occurred with highways. Highway engineers are aware of this and are searching for new facts.

The road test at Malad, Idaho, being conducted by the Highway Research Board for the Western Association of State Highway Officials, is an example of such basic research work by highway engineers. . . . The projected Illinois road test of the American Association of State Highway Officials is another example of such basic pavement research. All interests should participate in these research programs so that they will accept the results as research findings.

• The Maryland Road Test showed that a pavement, capable of carrying relatively few axle loads of design weight, could begin to show severe distress when the frequency of heavy axle applications approached high density traffic. This is of real concern to highway engineers.

• I think we can all agree that an automotive engineer must have specifications before he can begin intelligently to develop a design. Even then he needs a lot of test work to determine whether his design is adequate to meet the specifications. The size and weight limitations and the bridge formulas have served as such specifications for the highway builder, and in this respect, have been of great benefit to the public.

• There is a third factor in regard to size and

weight limitations which the author has not mentioned. This is the question as to what do the commodities want in the way of size and weight limits for their transportation over the highways. Stated another way, "What commodities, because of either their very heavy density and/or their minor importance to the economy of these United States, are not entitled to visibly full loadings in the cargo bodies of highway freight vehicles."

• There have not been brought together facts about payload weight requirements of commodities, about operating costs of trucking equipment of different load capacities, and about the range of costs of highways built to carry different axle and gross weights. The trends and values of these three factors must be considered jointly to develop an economical compromise of axle and weight limits. A committee of the Highway Research Board has undertaken the task of collecting data on these three factors.

Emil P. Gohn,

Atlantic Refining Co.

• This country's achievement of economic prosperity is one of the highlights of modern civilization. Its rapid development was encouraged to no small degree by the fact that *we had* the best and most extensive highway system in the world.

• There is no better way to counteract restrictive legislation than by removal of the causes for such action. The greater the public acceptance of our vehicles, the less the possibility of having restrictive laws passed.

• Further reductions in transportation costs through refinements in maintenance and operation procedures are becoming increasingly difficult to realize. On the other hand, liberalizing vehicle laws on the statute books can have a considerable effect on promoting increased highway use and corresponding reduction in operating costs. By the same token, the introduction of restrictive legislation could result in prohibitive operating costs.

In an eastern state, there was introduced recently a bill which would have drastically reduced the efficiency of a now popular semitrailer unit. Had this bill passed, it is estimated that highway transportation costs in that state would have increased 30%. Thus, by a single stroke of the pen, the savings resulting from years of maintenance refinements and operating techniques would have been wiped out.

Ernest P. Lamb,

Chrysler Corp.

• Present size and weight restrictions are limiting the development of highway transportation. Further, the dependence of the entire nation on trucks has reached the stage where any retarding effect on truck transportation has similar effects on the entire national economy. For the benefit of the public, there is a need for:

• Uniformity—The same vehicle or combination with identical loads on all through highways of the country.

• Length—A minimum combination length which will permit the use of conventional equipment.

• Width—Overall body width of 96 in. with 102 in. over the rear tires.

• Height—A uniform overall height limit of 13 ft.

• Bridge formula—Modification or removal of these restrictions.

• Axle spacing—Removal of these restrictions.

• Axle capacity—A uniform permissible load of approximately 22,000 lb per axle.

• Gross vehicle or combination weight—Limitation by number and capacity of axles.

Fred B. Lautzenhiser,

International Harvester Co.

• It is not likely that we will know the answer to the size and weight problem until after the completion of Highway Research Board Project No. 5, "The Economics of Motor Vehicle Size and Weight," and the phase of it that will be constituted by the American Association of State Highway Officials' contemplated road test.

Author's Closure to Discussion

I am indebted to Mr. Kibbee for his correction of my conception of the bridge formula. It is even worse than I thought. No wonder most of the states using it resort to a tabulation! His remarks undoubtedly reflect the attitude of over-the-road operators in general and, as such, are most appropriate to this discussion.

As usual, Hoy Stevens has contributed constructively and informingly to the subject under consideration. His outline of research projects now planned and in process, and particularly the objectives in view is most encouraging. That's all we want—the facts. We would have no objection whatever to size and weight limitations if they were based on facts, current facts, and if sufficient flexibility were retained to enable them to keep pace with future developments.

I must agree when he says that size and weight limitations *in the abstract* might be of benefit to the public; that the principle is sound, even though the specific limits are in error. Unfortunately, the public is being forced to suffer from the effects of the restrictions as they are and therefore cannot enjoy the benefits which might accrue were they more realistic and equitable.

I like Emil Gohn's statement: "There is no better way to counteract restrictive legislation than by removal of the causes of such action." In the spirit of this thought, it might be profitable to determine what these causes are. Are they:

Improper design of vehicles?
Heedless operating practices?
Inadequacy of roads and bridges?

Perhaps all three have combined to bring about the enactment of present limitations.

Until the facts which we so sorely need are determined, I think, in general, Mr. Lamb's prescription would be a safe guide for new and amended size and weight restrictions. However, I still contend that, so long as there are such vast sectional

differences in terrestrial formation, climate, and density of population as now exist in the United States, regional, rather than country-wide uniformity is desirable.

Mr. Lautzenhiser has put his finger on what might prove the most significant current research project bearing on this problem—the economic study. After all, what we have been discussing here is basically an economic question. So, in closing, I should like to repeat: Equitable size and weight legislation is that which fosters the most efficient use of the combination of the vehicle and the highway, to the end that the public will receive the maximum return on its investment in highways and bridges through convenience, celerity, and economy of transportation.

Fuel Injection Rates . . .

. . . can be measured in a firing engine. New method employs strain gage to measure changes in pressure inside spray tip.

Based on paper by **R. J. Wehrman, H. R. Mitchell, and W. A. Turunen** Research Laboratories Division, GMC

A METHOD has been developed that allows fuel injector performance to be measured in a firing engine at the same time that other pertinent data are obtained.

Basically, the method treats the spray tip holes as a flow metering element. The injection pressure versus time curve is determined by means of a strain gage for a representative cycle, from which the fuel injection rates are obtained by using a suitable pressure versus fuel flow rate calibration.

The strain gage is of the electrical resistance type and it is mounted on the injector spray tip.

A change in pressure inside the spray tip produces a corresponding change in the strain of the spray tip walls, thereby causing a change in the strain-gage resistance. A modified d-c bridge circuit converts this resistance change into a corresponding voltage variation. This voltage signal is then amplified and fed into a cathode-ray oscilloscope. The pressure-time trace produced is recorded photographically.

The actual test work was conducted on a GM 3-71 diesel engine, which was instrumented with a special electrical timing device to provide the time calibration on the oscilloscope trace.

This device consists of a magnetic pickup attachment mounted on the end of the crankshaft, which, in conjunction with a special stroblight trigger circuit, superimposes the two timing pips on the trace exactly 30 crank angle deg apart. The pickup unit can be rotated with an indexed head, thus providing a means of moving the pips back and forth horizontally on the injection pressure trace. By moving the left pip, whose position is calibrated with the indexed head in crank angle degrees, to coincide with the beginning of injection on the trace, the beginning of injection can be determined. The same process can be used to locate the end of the injection.

A separate fuel system is provided for the instrumented injector. Incorporated into this fuel system is a burette for volumetric determination of the fuel consumption by the instrumented injector and a system of pumps, pressure regulators, and heat exchangers for controlling the pressure and temperature of the fuel. For most of the test work, these pressures were set at 25 psi on the inlet and 15 psi on the outlet of the injector. The other two injectors were supplied from the regular engine fuel system.

In the initial stage of the development of this method, much preliminary work was done on a bench test setup in which the injector was actuated in a manner similar to its operation in an engine. By this means the added complications arising from the pressure and temperature conditions exisiting in the engine combustion chamber were avoided. The same systems of metering fuel to the injector and providing a time calibration on the oscilloscope trace were used on this setup as was provided for the engine work.

This new method of measuring fuel injection rates has several advantages and disadvantages as compared with the rotating receiver method, in which the rate of fuel injection is measured by passing a series of collecting cells under an injector nozzle during the injection period. The advantages are:

1. More comprehensive data are obtainable. In addition to fuel injection data, information may also be obtained on injection pressures, injection timing, and check-valve vibrations. The cause and effect relationships existing between these variables may be studied.
2. It can be used in an operating engine or on a bench test setup.
3. Transient pressure changes may be observed and studied.
4. No changes in the fuel flow passages of a standard injector are required.

The disadvantages are:

1. It is more complex and less direct than the rotating receiver method.
2. It requires the use of a high-pressure pump if injection pressure data are desired.
3. Installation of the strain gage requires skilled personnel.

(Paper "Measuring Rate of Fuel Injection in an Operating Engine" was presented at the SAE Annual Meeting, Detroit, Jan. 15, 1953. Paper will be printed in full in the 1953 SAE Transactions. Complete paper is also available from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

How Boron Enhances

Findings on Boron in Steel . . .

1. The solubility of boron in austenite is relatively low. It increases with increase in temperature in the gamma range and is of the order of 0.003% at 970 C.

2. Hardenability of certain steels does not depend critically upon the amount of boron present but upon its form in the steel. For example, 0.001% boron or less is often as effective as 0.002 to 0.006% boron. Thus, as little as one boron atom to 20,000 to 40,000 iron atoms is sufficient to have a maximum effect on hardenability.

3. Boron can exist in different forms in steel—in solid solution or as compounds. Only the boron that is in solid solution in austenite is effective in the enhancement of hardenability. Boron can be converted from the effective (solid solution) to ineffective form (compounds) by heating to excessively high temperatures for long periods.

4. The boron atom is slightly larger than the carbon atom. Like carbon, it is located interstitially in the gamma iron lattice.

5. The diffusion rate of boron in gamma iron is of the same order of magnitude as that of carbon.

6. Boron, similar to carbon, is lost in the decarburized zone of boron-treated plain carbon steels.

7. The effectiveness of boron in increasing hardenability decreases (within limits) as the carbon content of the steel is increased. Its effectiveness is practically nil in steels containing about 0.8% or higher carbon. Boron does not improve the hardenability of steels having either high soluble nitrogen or oxygen content. However, boron does improve the hardenability of high nitrogen steels in which the nitrogen is in the form of titanium or zirconium nitrides. It is also effective in thoroughly deoxidized steels low in soluble nitrogen.

8. Boron has no significant effect in retarding the beginning of the transformation of austenite in steels isothermally transformed just below A_{e1} temperature (about 710 C). Boron in solid solution does have a marked effect in retarding the transformation rate of austenite to ferrite isothermally transformed at the nose of the S (TTT) curves (about 600–500 C). This is a nucleation effect; not a decrease in rate of growth.

9. Boron in excess of about 0.002% has no significant effect on the critical temperatures (A_1 & A_3) of steel.[a] However, the results of recent experiments indicate that the A_{c3} of iron is lowered appreciably (910 to 849 C) by about 0.001% boron. Apparently, the M_s temperature is not appreciably affected by boron.

10. Boron increases the tendency of steels to become coarse-grained,[a] although this can be offset by the addition of grain-growth inhibitors. Boron appears to increase somewhat the impact (notched bar) toughness at room temperature of steels quenched to martensite and tempered to high hardness levels. When boron-treated steels are tempered to low hardness levels, the notch toughness is usually somewhat inferior to that of untreated steels.[a]

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[a] U. S. Bureau of Standards Journal of Research, Vol. 39, No. 1, July 1947 (RP1815) pp. 67–131: "Influence of Boron on Some Properties of Experimental and Commercial Steels" by T. G. Digges and F. M. Reinhart.

the Hardenability of Steel

Thomas G. Digges, Metallurgist, National Bureau of Standards

Excerpts from paper "The Action of Boron in Enhancing the Hardenability of Steel" presented at a meeting of Division VIII—Boron and Alternate Steels of the SAE Iron and Steel Technical Committee, Detroit, May 18, 1953.

THE effectiveness of boron appears to be due entirely to its action while in solid solution in austenite. The boron that is undissolved or in the form of compounds at the time of quenching is either without effect or decreases hardenability by acting as transformation centers for austenite in the temperature range where fine pearlite is formed.

When boron enhances the hardenability of a steel, it decreases the rate of nucleation and not the rate of growth of ferrite and carbide. The boron atom, believed to be located interstitially in the gamma iron lattice, is effective in retarding either the rate of formation of nuclei or the rate of their growth to the critical size necessary for transformation to begin, or both.

These conclusions are strongly supported by a review of the theories proposed in the literature and of the facts fairly definitely known about the action of boron in steel.

I. Review of the Literature

The action of boron in increasing the hardenability of steel is not too definitely known, but tentative explanations have been reported in the literature. These theories may be conveniently classified on the basis that the improvement is due (1) to a reaction of boron with some other element to change the condition of the latter and (2) to boron in solid solution at the time of quenching.

Grossmann[1] suggested the possibility of boron being present, at least in part, as stable carbides.

According to Allen,[2] Bain was of the opinion that boron has little effect as an alloying element but more likely acts as a sort of a cleansing agent, perhaps in some connection with the nitrogen content of the steel.

Chandler and Bredig[3] were of the opinion that nitrides act as nucleating agents in the decomposition of austenite, especially for the rejection of ferrite. The hardenability effect of boron, either alone or in combination with other elements, appears to be the influence of a fluxing agent upon the particle size of nitrides of other elements, such as those of silicon, aluminum, titanium, and zirconium. Thus, boron converts particles of harmful critical size into particles of larger size unable to effect nucleation.

Corson[4] assumed that boron increases hardenability by its action in removing something from the steel (possibly free nitrogen) that exists in very small amounts by weight and which has a deleterious effect on hardenability.

Dean and Silkes[5] believed that the effect of boron on hardenability was due to a dispersion rather than a solution in austenite. Presumably the boron in excess of the small amounts required for maximum hardenability reacts with some other constituent in the steel.

Boss[6] speculated that boron increases the hardenability of steel by the removal of the last trace of oxygen, but that boron itself is harmful to harden-

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[1] **Metal Progress**, Vol. 42, No. 1, July 1942, pp. 80–81, 124, 126: "Hardenability Calculated from Chemical Composition" by M. A. Grossmann.

[2] **Steel**, Vol. 112, Feb. 15, 1943, pp. 67–68: "The 'great boron mystery' lends zest to progress of NE steels" by A. H. Allen.

[3] Transactions of American Society for Metals, Vol. 37, 1946, pp. 179–184: discussion by H. T. Chandler and M. A. Bredig of paper "Factors Affecting the Hardenability of Boron-Treated Steels" by R. A. Grange and T. M. Garvey.

[4] Transactions of American Society for Metals, Vol. 37, 1946, pp. 184–185: discussion by M. G. Corson of paper "Factors Affecting the Hardenability of Boron-Treated Steels" by R. A. Grange and T. M. Garvey.

[5] Bureau of Mines Information Circular IC 7363, Sept. 1946: "Boron in Iron and Steel" by R. S. Dean and B. Silkes.

[6] **Metal Progress**, Vol. 51, No. 2, Feb. 1947, p. 265: letter "Is the Hardenability of Boron Steels Indirectly Due to Complete Deoxidations?" by G. H. Boss.

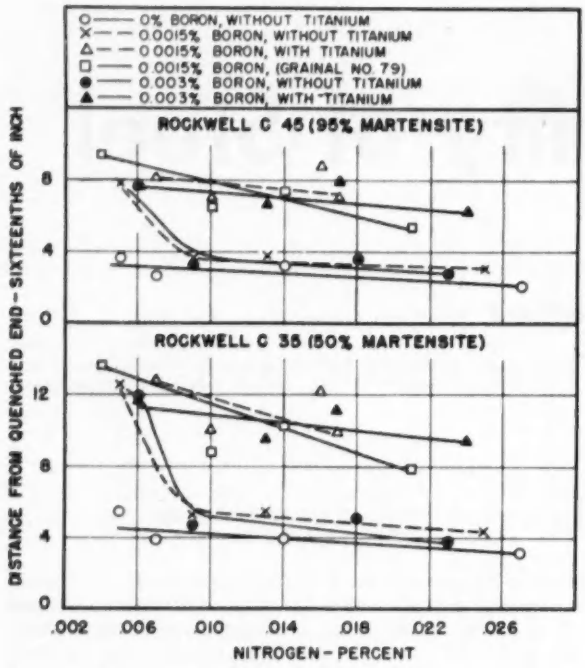


Fig. 1—Influence of nitrogen on the hardenability of experimental steels containing 0.3% carbon and 1.6% manganese

ability; a small amount of oxygen is also detrimental to hardenability.

Lippert[7] stated that boron, similar to any other alloying element, must be in solid solution to be effective in increasing hardenability.

Grange and Garvey[8] assumed the presence of boron in steel in both an effective and ineffective form. The effective form is capable of dissolving in austenite, whereas the ineffective form does not enter into austenite solid solution. The small boron atom is pictured as forming an interstitial solid solution with gamma iron.

The boron atoms are preferentially located in the grain boundaries of the austenite just prior to its transformation, and their presence lowers the rate of grain boundary nucleation and thus increases hardenability. As boron has a relatively low solubility in austenite, some of the boron atoms may precipitate as a compound and thus form a "film" at the austenite grain boundaries that is supersaturated with respect to these atoms.

This precipitate seemingly forms rapidly and in advance of the usual transformation of austenite to ferrite; only those boron atoms that remain in solid solution are effective in decreasing the rate of nucleation of ferrite and hence increasing the time required for austenite to transform. Heating steels at a high temperature for a long time may convert effective into ineffective boron; the latter may be some stable chemical compound of boron that gradually forms at high temperature.

In some work carried out at the National Bureau of Standards[9] no definite correlation was found between the amount of boron added or retained in aluminum-killed experimental and commercial open-hearth steels and the hardenability as determined by the end-quench test. In many of the steels, the optimum hardenability was obtained with small additions of boron (0.001% or less retained) whereas in others the hardenability increased continuously with increase in boron up to about 0.006%. In still other steels, the addition of boron either as a simple or a complex intensifier was without effect or impaired the hardenability. The hardenability of boron-treated steels also varied with the state of deoxidation and with the nitrogen content.

II. Influence of Nitrogen

The influence of nitrogen on the hardenability of boron treated steels[9] is clearly illustrated in Fig. 1. These curves summarize the results obtained from end-quench tests of steels containing 0.3% carbon, 1.6% manganese, with and without boron or titanium and with different nitrogen content. The distance from the quenched end of the bar corresponding to a structure of 95% martensite is plotted against the nitrogen content in the upper part of the graph, whereas the distance from the quenched end corresponding to 50% martensite is shown in the lower part of the figure. As each group of curves shows the same general trends, attention will be confined to the lower group.

The hardenability of the base steel without boron or titanium (open circles) was not materially affected by a change in nitrogen from 0.003 to 0.027%. However, the steels containing 0.0015 or 0.003% of boron without titanium (represented in this figure by the crosses and filled in circles) were markedly affected by a variation in nitrogen of this magnitude. (The boron additions were made with ferroboron.)

In the low nitrogen range (0.003 to 0.005%), the addition of boron resulted in the expected normal increase in hardenability, whereas this property was not significantly affected by the addition of boron in the steels containing 0.010% or more of nitrogen. That is, the beneficial effect of boron on hardenability was obtained only in the low-nitrogen steels. However, the upper curves are for a steel treated with Grainal which contained titanium or steels treated with ferroboron with a separate addition of titanium. The position of these curves shows that the action of boron in increasing hardenability was maintained to a considerable degree in the high-nitrogen steels by the addition of titanium either as a separate addition

[7] Iron Age, Vol. 150, No. 21, Nov. 19, 1942, pp. 41-44: "Boron" by T. W. Lippert.

[8] Transactions of American Society for Metals, Vol. 37, 1946, pp. 136-174: "Factors Affecting the Hardenability of Boron-Treated Steels" by R. A. Grange and T. M. Garvey.

[9] U. S. Bureau of Standards Journal of Research, Vol. 39, No. 1, July 1947 (RP1815) pp. 67-131: "Influence of Boron on Some Properties of Experimental and Commercial Steels" by T. G. Digges and F. M. Reinhart.

(ferro-titanium) or as a complex intensifier (Grainal). Similar results were obtained with nitrogen-boron steels treated with zirconium.

The results of this study indicated that the role of titanium or zirconium in enhancing the hardenability of boron-treated steels containing high nitrogen is to act as a "fixer" for nitrogen by forming nitrides insoluble in austenite at heat-treating temperatures and thus decrease the amount of soluble nitrogen available for reaction with boron. Both titanium and zirconium appear to have a greater affinity for nitrogen than does boron, and sufficient amounts of either titanium or zirconium in high-nitrogen steel treated with boron have a desirable overall effect on hardenability similar to that of a boron addition to a low-nitrogen steel.

The theories and results already discussed were based upon experiences acquired and experiments carried out before about 1945–1946. Since the boron steels were developed principally during a period of national emergency, more attention was paid to the development and application of the steels than to the mechanism of the boron effect on hardenability.

III. Results of Recent Investigations

Since about 1946, additional studies have been made of this mechanism. One such study was made at the National Bureau of Standards.[10] High purity alloys consisting of (1) iron and boron, (2) iron and carbon, without and with boron, and (3) iron-carbon-manganese without and with boron were prepared in the laboratory and commercial open-hearth steels were procured for use in this investigation.

1. *Effects of Boron and Initial Structure on the Hardenability of High-Purity Alloys*—Some of the results are summarized in Fig. 2, in which the critical cooling rate is plotted against the quenching temperature. The critical cooling rate is defined as the slowest rate that the steel can be cooled to produce in the quenched specimen a completely martensitic structure—that is, the slowest cooling rate that will fully harden a steel. Obviously, the critical cooling rate can be used as an index to hardenability; the slower the critical cooling rate, the deeper hardening is the steel. With suitable equipment this method of evaluating hardenability is capable of producing results of a high degree of accuracy, and it is applicable for alloys having a wide range in hardenability.

Small specimens (1/10 in. square by 0.04 in. thick) were quenched under accurately controlled conditions and photographic records were made of the time-temperature cooling curves. Some of the specimens were prepared from the ingots as cast (represented by Curves A). The other specimens were from bars that were hot worked and, after the scale and decarburized layer were removed, were homogenized by heating at 1700–1900 F in a high vacuum (Curves B). The cooling rates were then correlated with the microstructures of the quenched specimens.

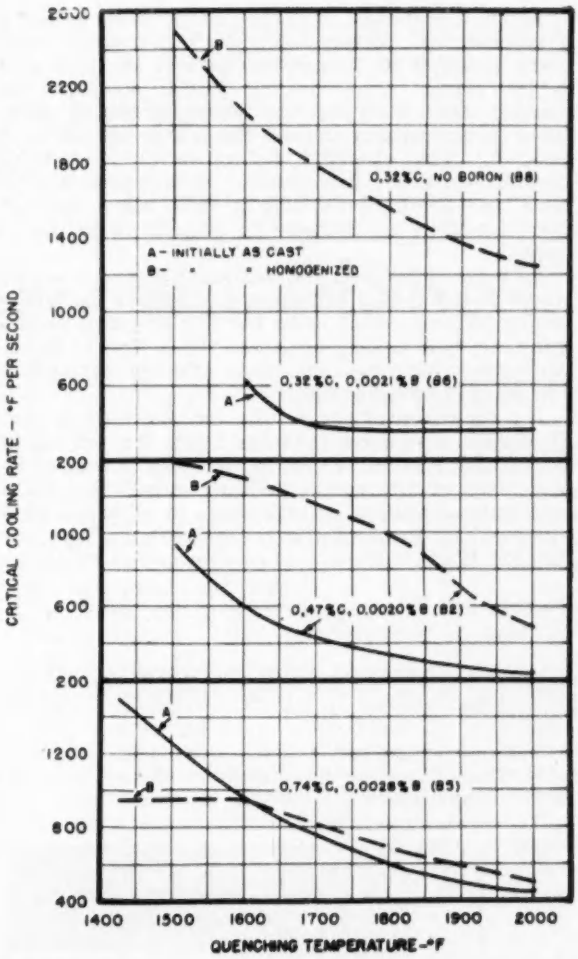


Fig. 2—Relation of critical cooling rate to quenching temperature of some high-purity iron-carbon alloys. Critical cooling rate was taken as the average cooling rate through the range from 1110 to 930 F (nose of the S curve for the high-purity alloys) which produced in the quench specimen a structure of martensite with fine pearlite in an amount estimated to be 0.2%. No curves are shown for alloys containing 0.5 or 0.7% carbon without boron because no significant difference was obtained between the critical cooling rates of the homogenized specimens prepared from these alloys and those containing about 0.002% boron, provided the carbon content and austenite grain size were alike

With an initial structure as cast (Curves A), the hardenability was markedly improved by the addition of boron to alloys containing 0.32 or 0.47% carbon but the presence of boron in the 0.74% carbon alloy had no material effect on the critical cooling rate or hardenability. The lower hardenability (higher critical cooling rate) of the initially cast specimens of this alloy when quenched from 1425 or 1500 F was due to incomplete solution and non-

[10] U. S. Bureau of Standards Journal of Research, Vol. 41, No. 6, Dec. 1948 (RP1938) pp. 545–574: "Effect of Boron on Hardenability of High-Purity Alloys and Commercial Steels" by T. G. Digges, C. R. Irish, and N. L. Carwile.

uniform distribution of carbon in austenite at these temperatures. Appreciably higher cooling rates were required to completely harden the 0.32 and 0.47% carbon alloys in the initial condition as homogenized than as cast when quenched from alike temperatures within the range of 1500 to 2000 F. The observed difference could not be ascribed to grain size effects. It is interesting to note that the hardenability of these alloys did not decrease with an increase in quenching temperature.

As boron improved the hardenability of the two alloys in the initial condition as cast but was practically without effect after hot working and homogenizing, it is clearly apparent the action of boron on hardenability was adversely affected during the course of these treatments.

A comparison of the results for the initially cast specimens also show that the boron-treated alloys containing 0.32 and 0.47% carbon had critical cooling rates of the same order of magnitude when austenitized alike and these rates, in all cases, were slower than those of the boron-treated alloy containing 0.74% carbon. Thus, the action of boron on the hardenability of these high-purity alloys as cast varied with the carbon content; the effectiveness decreased with an increase in carbon, the improvement being very pronounced with 0.3%, intermediate with 0.5%, and nil with 0.74% carbon.

2. *Diffusion of Boron in Austenite*—Some experiments were made with commercial steels to determine the rate of diffusion of boron in austenite.[10] Specimens were decarburized by heating in a reducing atmosphere at 1900 F for 8 hr and then cooling slowly in mica. Typical results are shown in Fig. 3. The depth of the decarburized layer for this particular specimen is shown by the structure reproduced in the photomicrograph at the top of the figure (reproduced in conformance to the scale of the abscissa). The boron content in the decarburized specimen, as determined spectrographically, is plotted against the distance from the original surface of the specimen. The heavy horizontal line represents the nominal boron content of the steel—that is, 0.0038%.

There was a high concentration of the boron at the surface of the specimen, which was probably due to a reaction of the diffusing boron with oxygen in the furnace atmosphere to form boron oxide (B_2O_3). The boron content slightly below the original surface of the specimen (0.003 in.) was less than the value that could be accurately determined by the method employed (sensitivity about 0.0002% boron). A concentration gradient extended from this zone where the boron was practically depleted to a depth as great as the severely decarburized layer. This indicates that the diffusion rate of boron in gamma iron (or a steel containing 0.4% carbon) was of the same order of magnitude as that of carbon. This was confirmed by a computation of the coefficient of diffusion of boron from these and additional data and later by other investigators.

It is, therefore, logical to assume that the mechanism of the diffusion process for boron in austenite is quite similar to that of carbon—that is, the boron atoms are located interstitially in the gamma iron lattice.

According to Wever,[11] the radius of the boron atom is about 0.95 angstrom units and the radius of the carbon atom is approximately 0.75 angstrom units. Therefore, the size of the boron atom is also favorable for it to be located interstitially in the gamma iron lattice.

Other investigators are now making a study of the mechanism of the boron effect. Wright Air Development Command is sponsoring projects at University of Chicago (Dr. Nicholson), at Ohio State University (Prof. Spretnak), and at Battelle Memorial Institute (Mr. Manning). The projects have been active for one to two years, but they have not reached the publication stage. The studies at both Chicago and Ohio State include a determination of the iron-boron equilibrium diagram. The results of the two investigations appear to agree in that the solubility of boron in alpha iron at the A_{c3}, 906 C (1660 F), was somewhat greater than its solubility in gamma iron at about the same temperature, and the solubility of boron in gamma iron increases with increase in temperature. Spretnak, in a recent publication,[12] estimated the value to be 0.003% boron at 970 C (1780 F).

[11] World Engineering Congress Proceedings (Tokyo) 1929, Vol. 34, pp. 239-250: **"Zur Systematik der Eisenlegierungen"** by Franz Wever.

[12] Journal of Metals, Vol. 5, No. 3, March 1953, pp. 445-446: "Grain Boundary Films in Boron Steels" by J. W. Spretnak and Rudolph Speiser.

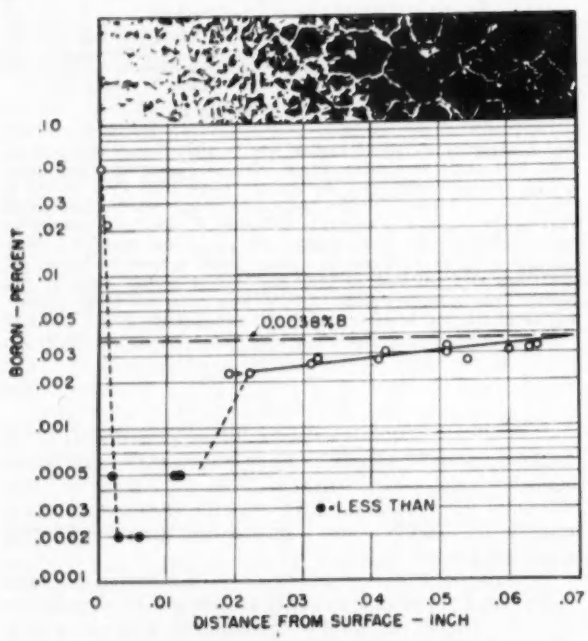


Fig. 3—Distribution of boron in a decarburized layer of a commercial boron-treated steel. Left edge of the photomicrograph corresponds to the original surface of the specimen and the characteristic structure (not decarburized) is shown at the right, etched with 1% nital. Determinations for boron by spectrographic analysis were made at the surface and at various levels below this surface of the specimen. Nominal boron content was 0.0038% (heavy horizontal line)

Problems with

Hydraulic Systems

for

Tomorrow's Planes

Part II – Reliability

HYDRAULIC systems for tomorrow's aircraft must and can be designed to perform their many jobs reliably.

They will operate such essential devices as wing slats, bomb bay doors, canopy and escape hatches, cowl flaps, arresting hooks, and armament controls. Malfunctioning of the hydraulic system in a military plane can abort a mission and maybe kill the pilot.

So the hydraulic system must operate properly at all times, even though some of its parts are subject to the 400 F-plus temperatures of turbine engines one time and the whole system is cold-soaked at –65 F on an Arctic field another time. (Some of the paths being explored to insure that future hydraulic systems can meet extreme temperature requirements were detailed in Part I of this article in last month's Journal.)

Reliability—if you define it as the probability that there will be no failure from any cause within the system—is only part of the problem, of course. Hydraulic systems must not fail from external causes either; in other words, they must have "immunity." For example, a tube may be very reliable in flight, but if it is located where mechanics will use it as a step or where falling wrenches strike it, the tube will have poor immunity.

It takes both reliability and immunity to insure "dependability." And dependability is what we want to maximize.

Current trend is toward considering the dependability of the whole aircraft. Take the case of high-speed guided missiles. Dependability is chiefly a function of the immunity of the whole missile from attack by other defensive missiles. The way to get missile immunity is through high performance. The vehicle must be compact, even though components suffer from the squeeze. Reliability of the hydraulic system and its components will be only as good as designers can make it within stringent bulk and weight limits and no better.

But there's a lot designers can do to improve reliability within the limits imposed on missiles and other kinds of aircraft.

Tips on redesign and on initial design for reliability in hydraulic systems appear on the next 2 pages.

This is the second part of a two-part series. Part I covering extreme temperature problems appeared in last month's SAE Journal. Part II is based on these papers:

Design for Increased Reliability of Aircraft Hydraulic Systems

—by L. M. Chattler

Navy Bureau of Aeronautics

Designing Hydraulic Systems to Increase Dependability of Tomorrow's Airplanes

—by Howard Field, Jr.

Consolidated Vultee Aircraft Corp.

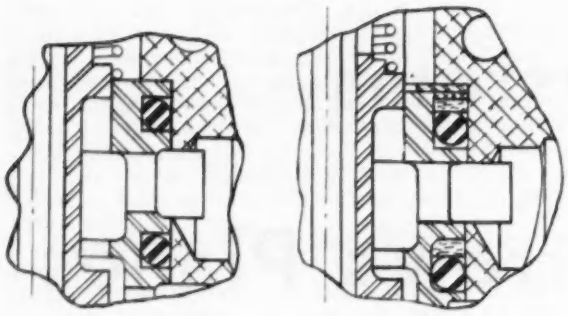
Design and Development of Aircraft Hydraulic Components for Increased Reliability

—by J. W. Kelly

Adel Division General Metals Corp.

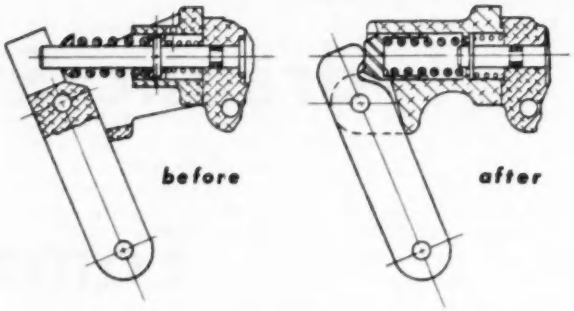
These papers were presented at the SAE National Aeronautic Meeting, New York, April 22, 1953. The complete papers are available in multilithographed form from SAE Special Publications Department at 25¢ each paper to SAE members and 50¢ to nonmembers.

Tips on Redesigning for Reliability



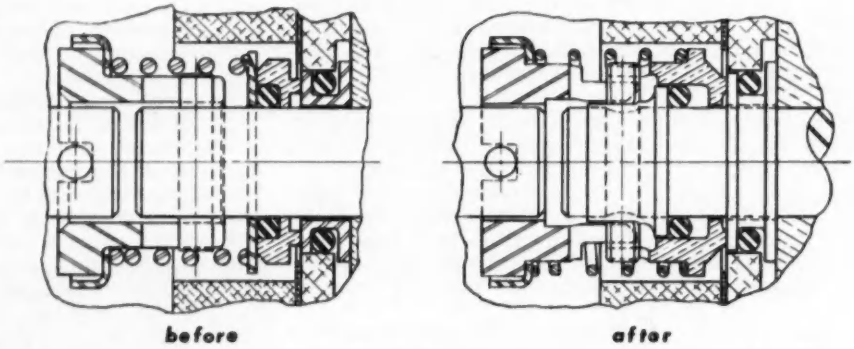
before *after*

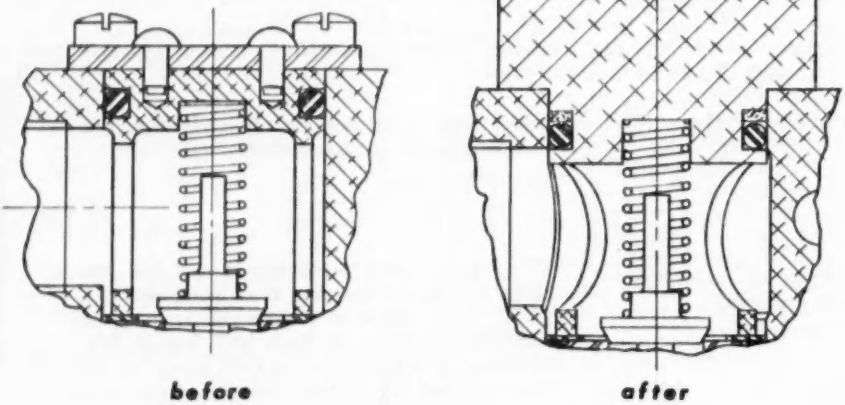
Repeated stress reversals overtaxed the flange of this o-ring groove. Transferring the load to the valve body, which could better stand it, made the component more reliable.



In prototype tests of this manual override, the cam showed a tendency to rotate and make contact with the side walls of the mounting bracket. Addition of a cylindrical spring guide between the spring and the lever improved the design. The guide eliminates binding and also keeps dirt out of the spring.

O-rings in this coupling and seal on an electrically driven hydraulic pump assumed a square section after field service. They also showed evidence of rotation on the inside diameter. Apparently the friction between the shaft, the o-ring, and the inside diameter of the mechanical seal was less than the friction between the rotating seal and its associated seal plate. The coupling was redesigned to provide a mechanical drive connection between the shaft and the seal, and the seal was pressure loaded. These features took care of the extreme pressure conditions encountered in service but neglected in the specification. The features could have been incorporated at less cost in the original design if the coupling designer had been informed more fully.





Impulse pressures were harder on this poppet valve than burst tests. The component manufacturer had to beef up the cap to enable the unit to pass the surge test the airframe manufacturer imposed. Incidentally, strengthening components to withstand severe surge tests costs weight and money. It shouldn't be done unless sharp surge is actually likely to occur in service.

Checklist for Designing Initially for Reliability

AIRCRAFT HYDRAULIC SYSTEMS

Complexity	Reduce the number of components. Simplify system arrangement. Eliminate marginal systems. Replace sequence functions with mechanical linkages. Perform a failure analysis on completed design.
Interconnected Systems	Don't interconnect. Examine systems for interconnections in pressure lines, return lines, reservoir pressure lines. Emergency components must not be part of the normal system.
Peak Pressures	Check effect of peak pressures on pressure regulators, solenoid valves, sequence valves, flow regulators. Check effect of *g* forces on services actuated. Conduct a final peak pressure check with instruments.
Back Pressure Effects	Eliminate designs affected by back pressure. Check each subsystem in every control position for back pressure effect when other subsystems are operating. Check residual back pressure for effect on emergency operation.
Reduced Flow Effects	Eliminate designs affected by reduced flow. Check system functioning for all obtainable flow rates. Check function of devices dependent on flow rate for flow range. Check single-pump performance on multi-pump systems. Check shifting devices with reduced flow, considering leakage.
Increased Flow Effects	Keep flow-increasing devices to a minimum. Check effect on detail design of components. Check peak and back pressure effects. Check effect on subsystem functioning. Check exhaust direct to reservoir. Check effect where acceleration and air loads drive actuated service, especially large-volume cylinders.
Accelerations	Consider *g* capabilities of aircraft when designing hydraulic systems. Check effects of *g* forces on each component, internal mechanism, fluid columns, fluid masses, components without pressure in emergency, on the actuated service, and other significant masses.
Depressurization	Check systems for depressurization, especially sequenced subsystems. Then determine effect. On intentionally depressurized systems eliminate marginal electrical mechanical sequencing.
Air Inclusion	Design for automatic bleeding, to prevent air inclusion. Check all components for air inclusion. Consider the effect of *g* and air loads. Check air inclusion on dead systems. Check multi-pump systems for air bleed. Check air inclusion on filling.
Temperature	Avoid hot spots. If unavoidable, insulate or provide cooling or ventilation for the compartment. Take advantage of cooling by radiation. Design for high component efficiency. Avoid wasting power in flow regulators with high pressure differentials. Avoid circulating systems where heat is generated when no work is done. Where high-power drives are used for intermittent loads, make provisions not to waste power during low-load conditions. Check low-temperature performance.

Developing MANAGERIAL TALENT is a continuing process

D. F. Timberlake, General Electric Co.

Based on secretary's report of Panel on Manufacturing Management held as part of the SAE Aeronautic Production Forum at the SAE National Aeronautic Meeting, New York, April 20, 1953. Leader was H. F. Dickie, General Electric Co.

IT'S management's duty to see that there are replacements for its own ranks on tap all the time. Management can do it only by continously seeking the right men—and, once they're hired, providing training opportunities for them.

Companies are always faced with retirements, deaths, promotions, and terminations. A survey of one well established company showed that slightly over 10% of managerial jobs require replacements every year. In another well established company the figure was 12%. In companies where most of the people started together at approximately the same age, the figure will be much higher by the time they approach retirement. To keep a company running smoothly, management must have replacements available all the time.

The way to begin is to spot the logical starting jobs, chart the paths of advancement to managerial positions, and figure out what qualifications men need to get on and go up the ladder. Then look for men who have the qualifications. But don't hold out for more in every man than you'll need.

In selecting men, make use of all the techniques you can. Consider things like education, experience, reports by previous supervisors, test results, and interviewers' ratings. Remember that none of them is infallible. Intelligence and psychological tests give useful indications, but they don't tell the whole story. Personal interviews fill in some details, but one trained interviewer may rate an applicant high while another trained interviewer may rate the same man low for the same job.

Educational requirements for prospective factory supervisory personnel are going up. The men who will make decisions concerning tomorrow's complicated automatic equipment will need an engineering background. So the trend is toward hiring engineering college graduates for factory supervisory personnel.

Some companies taking on college men for factory jobs have run into trouble, however. For one thing, salaries high enough to attract engineering graduates are way above the earnings of men who have risen through the shop to positions of similar rank. This situation may force a major rise in the middle salary brackets within the next five years, many people who have studied company salary structures believe. Right now, supervisors' earnings aren't much higher than those of hourly rated workers because for years we have been giving flat

Serving on the panel which developed the ideas in the accompanying article were:

H. F. Dickie, Panel leader
General Electric Co.

D. F. Timberlake, Panel secretary
General Electric Co.

C. L. Farrand,
Farrand Optical Co.

F. P. Holter,
Curtiss-Wright Corp.

Harry Lampe,
Republic Aviation Corp.

R. T. Nalle Jr.,
Westinghouse Electric Corp.

P. F. Weber,
Kollsman Instrument Corp.

Tips for Management on . . .

Factory Loading

- Don't load to full capacity. Allow for machine down time.
- Reserve Saturdays and Sundays for jobs that get behind schedule.
- Rely on overtime and subcontracting to take care of peaks.
- Use mechanized tabulating systems if loading is too complicated to handle economically by hand calculations.
- Set aside certain machines in a utility shop area to do repair and rework.

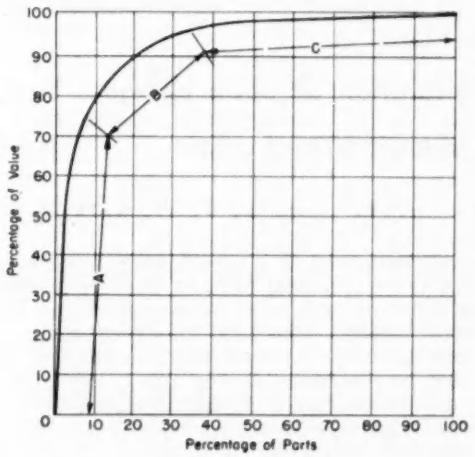
Inventory Analysis

- Put the most attention on the items that constitute the major inventory value. One way to do this is to set up an "ABC Inventory Analysis":

1. Extend the value of each piece in the product by the number of identical pieces. Include material, labor, and overhead. Exclude assembly labor. Price purchased parts at cost from the vendor.
2. Arrange the items in descending order of individual cost.
3. Accumulate the number and cost of the items. Plot them on a chart like the accompanying one.

In this case, the "A" components make up only 8% of the total but account for 75% of the cost. The "B" components, 25% in number, account for 20% of the cost. The "C" components, 67% in number, account for only 5% of the cost. Obviously the "A" and "B" items are the ones to watch most closely.

- Try to anticipate major design changes early enough to avoid scrapping parts, especially "A" and "B" items.
- Have inventory control report to someone outside production—such as the plant manager.



Production Controls

- Investigate mechanized production control systems. With only one typing of engineering data, combinations of variable and constant information can be reproduced automatically as often as desired. Yet the system is flexible. In some cases, mechanized production control is economic in plants employing as few as 500 or even 250 direct production workers.
- Review all production control office routines. Eliminate those no longer needed.
- Try instituting office quality control. Point out the cost of sloppy work and retyping. Pride is usually enough incentive to bring about improvement. Some companies, however, put office machine operators on piece work and pay only for good work. One company saved $3–4 in office overhead the first year for each $1 spent on an office quality control program aimed at reducing clerical errors.

Management Controls

- Take the budget as the master plan. Project sales, cash position, manufacturing costs, and other budget categories as far ahead as possible. Lay long-range plans accordingly.
- Establish standards for manufacturing losses, overhead expense, cost reductions, inventory turnover, shipping promises met, variance from standard costs, personnel turnover, and similar items.
- Let the forman know daily how his group is performing against the standards.
- Mechanize your production data collection and tabulation system, if that's necessary to analyze the data fast enough.
- Maintain an engineering schedule so that production schedules can be related to engineering releases. Even development engineering can be scheduled. Set dates for completion of preliminary specifications, drawings, prototype model, and so on. If engineering gets behind, production can then revise schedules accordingly.

cents-per-hour increases to both groups instead of percentage increases.

Another difficulty is that while engineering graduates are competent in technical matters, they don't get along with factory hands and with other supervisors. They don't seem to realize that getting along with people is a vital part of the job.

Some management experts feel that the way to solve this problem is to hire engineering graduates on a kind of supervisor's apprenticeship basis. This plan would give them several years of training under experienced factory supervisors.

Other management experts suggest directing strictly technical problems to a manufacturing engineering section for solution and leaving the rest of the operation in the hands of men who have risen through the shop.

Once a man is on the payroll, it is important to keep track of him. Here's how one company does it:

Each supervisory employee writes up his own job description, outlining what he believes to be the necessary qualifications to fill the job. The man's supervisor grades the individual on all standard qualities, such as judgment, initiative, and leadership. Next a four-man panel discusses the individual and the rating with the supervisor.

Then the panel discusses the rating with the man, pointing out shortcomings, suggesting ways of improving, and recognizing good qualities.

Cards on all employees are kept at a central location. When there's an opening, employees' cards are matched against the job requirements card. All the men who fit the job come to the attention of those making the selection.

Men who have been selected to start up the ladder need continuing training. Even small companies can provide it. They can, for example, arrange for one or two of their best qualified men to instruct a small group of top-level employees in modern management concepts. These men can, in turn, instruct men on lower management levels. Or the small company can bring in an outside educational firm to do all or part of the instruction job.

Small companies—and large ones too—can encourage their men to take management training courses like those offered by Harvard, Columbia, the University of Iowa, and the American Management Association.

Of course, there's no sense in training a man if there's no place for him to advance to, especially if you're asking him to invest some of his own time or money. It doesn't pay to mislead an employee on his chances for promotion—or to train the wrong man.

You have to supplement training with experience. To do this, one company has set up a junior board of directors. It makes recommendations on policy matters to the regular board of directors and can even commit funds up to a predetermined amount. Prospects for top management jobs get valuable experience on the junior board. And by observing their operation and results, senior management can make a very accurate estimate of juniors' ability.

Careful selection, adequate training, and opportunities to gain experience are what it takes to develop managerial talent.

(The report on which this article is based is available in full in multilithographed form, together with reports of the nine other panel sessions of the 1953 SAE National Aeronautic Meeting and Aeronautic Production Forum. This publication is available as SP-302 from the SAE Special Publications Department. Price: $2 to members, $4 to nonmembers.)

Aerodynamic Stability . . .

. . . of modern car can be improved by alteration of body design. Tests show most current bodies adversely affected by sidewinds and gusts.

Excerpts from paper by **W. E. Lay** University of Michigan and **P. W. Lett Jr.** Chrysler Corp.

ROAD and wind tunnel tests to determine the air resistance of automobiles is not uncommon, but little attention has been paid to the problem of the effects of sidewinds and gusts on car stability. Accordingly a unique test procedure was worked out, which involved the separation of body and chassis and installation of instruments between the two to measure the forces transmitted from body to chassis under highway tests.

Tests of sidewind effects showed that as the resultant wind direction changed from head-on, the total sidewise force exerted on the test car by the wind increased at a significantly greater rate than the cross-sectional area of the car normal to the wind. This was most noticeable at small resultant wind angles. The fact that resistance is a function of shape as well as cross-section normal to flow was responsible for this. For example, the increase in cross-sectional area normal to the wind was relatively small as resultant wind direction changed from 0 deg (head-on) to 10 deg, indicating a correspondingly small increase in sidewise force. However, resistance due to turbulence increased rapidly with this change in direction of 10 deg. The

increase in resistance due to turbulence was found to be most significant where the direction of resultant wind was less than 10 deg.

The location of the center of pressure of a resultant wind striking the car varied with the angle of the wind, but was unaffected by changes in wind speed. As shown in Fig. 1 the location of the center of pressure for a resultant wind angle 45 deg from the direction of travel was approximately 10 in. forward of the center of gravity. With a resultant wind angle 5 deg from the direction of travel the center of pressure was found to be 30 in. forward of the center of gravity.

The greater the distance between center of pressure and center of gravity, the greater the tendency to yaw and the poorer the aerodynamic stability. The center of pressure location for winds from any angle is dependent upon body shape. In a side view the larger the percentage of cross-sectional area forward of the center of gravity, the farther forward the center of pressure will be. For a particular resultant wind angle, the yawing moment varied with changes in wind speed exactly as did the sidewise force.

A gust striking the car at an angle to the direction of travel was shown to cause a sudden lateral displacement and to turn the car from its direction of travel. The corrective action of the driver stopping the car in its sidewise movement and turning it into the gust was responsible for the greatest forces recorded during a gust interval.

Whether gusts or sidewinds strike a moving car its aerodynamic stability will be determined primarily by: (a) the degree to which lateral thrust forces due to winds are equalized between front and rear wheels, and (b) the extent to which the air resistance of the car to winds from the side is reduced. Additional cross-sectional area rearward of the center of gravity and normal to crosswinds would definitely improve stability. (Paper, "Wind Effects on Car Stability" was presented at SAE National Passenger Car, Body, and Materials Meeting, Detroit, March 3, 1953. It was printed in full in 1953 SAE Transactions. It is also available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

Excerpts from Discussion

W. I. E. Kamm,

Stevens Institute of Technology

Perfect conditions can be realized only approximately in actual operation. Common variations in loading a vehicle displace the center of gravity and the attack point of the resultant lateral tire force. Changes in resultant wind direction affect the location of the center of pressure of the wind on the vehicle as described by the authors. For these reasons the center of pressure and the attack point of the lateral tire forces normally lie at different spots. Fundamentally stable operation can be secured if (a) the center of gravity is located initially so that it is ahead of the wheelbase midpoint for all common distributions of vehicle load, thus placing it in front of the attack point of the lateral tire forces, and (b) if stabilizing fins are made large enough to cause the center of pressure to lie behind the center of gravity at any resultant wind angle substantially different from zero.

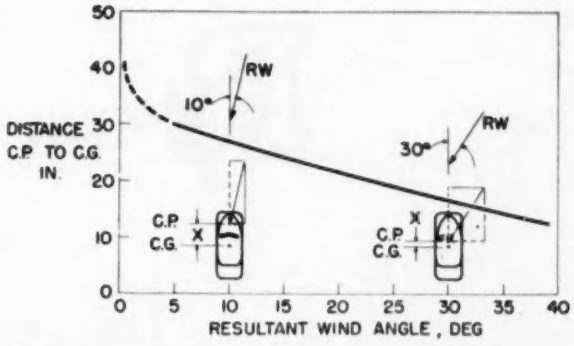


Fig. 1—Location of center of pressure in relation to center of gravity as it changes with change in resultant wind angle

Victor Boghossian,

Kaiser-Frazer Corp.

If air resistance of automobiles is gradually reduced by the normal evolution in body design, and little or no attention given to the problem of aerodynamic stability, we will be approaching a dangerous condition of instability. To stay within the scope of present styling trends it may be difficult to design a completely stable car, but it is possible to set a trend which is in the right direction by the proper proportioning of the car.

T. J. Kozier,

Ford Motor Co.

Would the authors clarify just what the center of gravity has to do with yawing moments on a car or truck. It would appear that a vehicle such as an automobile, bus, or boat, which is not entirely airborne, but is more or less fixed to the ground or water surface, exhibits a tendency to yaw which depends solely on the relative location of the center of pressure and the center of resistance.

Authors' Closure To Kozier Discussion

The applied forces here are wind forces that produce yawing moments. The resisting forces are tractive forces between tires and road. If the lateral forces due to sidewinds are balanced by the opposing lateral tractive forces no drift occurs. If the wind-induced yawing moment is balanced by an opposing moment produced by resisting tractive forces no yawing occurs. The application of a sidewind force to a body moving through air produces a tendency for the body to rotate about its center of gravity in every case where the center of pressure is not coincident with the center of gravity. Contact with the ground in no way alters this applied moment.

Rx for Aircraft Spark-Plug

Add TCP

FLIGHT tests with military and civilian aircraft show that a pinch of tricresyl phosphate (TCP) added to fuel will help alleviate spark-plug fouling. This test program points up the following conclusions:

1. The optimum TCP scavenger composition seems to be 1.0/0.1[1] all factors considered.
2. Fuel containing 0.1 theories TCP can be used advantageously in certain equipment to reduce spark-plug fouling without adverse secondary effects.
3. Fuel containing TCP can't be used indiscriminately in all aircraft with exhaust turbos, until some way is found to get around the deposit problem.
4. TCP is effective in controlling spark-plug fouling under conditions of extreme manual leaning. Both military and commercial operators are rapidly adopting such manual leaning to cut fuel consumption.
5. The greater the extent of spark-plug fouling, the more the relief offered by TCP.

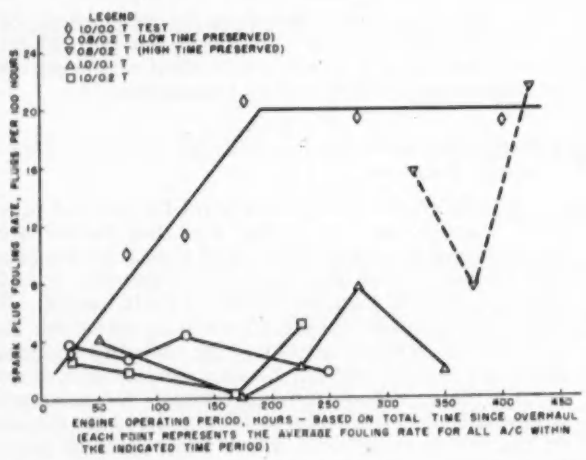


Fig. 1—Charted here are the spark-plug fouling rates against engine time since overhaul on Navy helicopters operated out of Ellyson Field, Florida

Following is a discussion of some of the results of the flight evaluation tests on some of the aircraft types used in the program:

Helicopters

One type helicopter in general use by the military was selected for this program because of the severe spark-plug fouling encountered. It was a two-place helicopter, designated by the Navy as an HTL model, powered by a Model 0-335, 200-hp, vertically installed 6-cyl aircooled engine. Because of the installation and the type of service, the engine is operated in auto-rich at substantially full power.

Table 1 summarizes the spark-plug fouling rate obtained with several fuels.

These data show a distinct improvement in fouling rate by the addition of TCP. Considering the accuracy of the data, they seem almost independent of the test scavenger composition, although the 0.2 TCP fuels are favored.

The data also are shown in Fig. 1, plotted as a function of engine time since overhaul. Time since overhaul appears to influence plug fouling rate with EDB scavenger, but not with EDB/TCP scavenger mixture. (That's excluding the high time preserved engine results, which are unusual because of deposits loosened by the preservative compound.)

Explanation of this seems to lie in the type of combustion chamber deposits formed by the scavenger. Those formed with fuel containing TCP tend to be a soft powder, which seems to have less tendency to lodge in the spark plug.

The services went to general use of TCP in service operation of this model engine when this flight test

[1] The numbers 1.0/0.1, or 0.8/0.2 refer to scavenger composition. The first part of ratio refers to the theories of ethylene dibromide (EDB) present, and the second to the theories of tricresyl phosphate (TCP) present, assuming 2 mols of TCP combined with 3 mols of tetraethyl lead to form lead phosphate.

Fouling

Scavenger to Fuel

C. R. Johnson and D. N. Harris, Shell Oil Co.

Excerpts from paper "Service Experience with TCP Fuel Additive" presented at SAE Annual Meeting, Detroit, Jan. 16, 1953.

program was completed. Detailed service results are not yet available. But general experience has been satisfactory, as would be predicted from results of this flight test program.

A number of commercial operators of this model helicopter have followed suit and also started using TCP. Their experience also is in line with predicted results. For example, Helicopter Air Service and the New York Police Department report no unscheduled spark plug removals and scheduled plug change periods are being increased from 25 to 50 hr.

B-36's

In the summer of 1951, the Air Force Research & Development Command started service tests of 0.8/0.2 fuel in B-36 aircraft at Carswell Air Force

Table 1—Summary of Helicopter Spark-Plug Removal Record (Not Including Routine Changes)

Test Fuel	Total Test Hours	Average Engine Time Since Overhaul, Hr	Plug Removals				Removal Rate, Plugs/100 Hr. Basis		
			Total	Fouled	Questionable	Not Fouled	Total	Fouled Plus Questionable	Fouled Only
1.0T edb/0.0T tcp Regular 91/98 (Base Line) 4.3 cc tel	1640	108	214	154	18	42	13.8	11.0	9.9
0.8 edb/0.2 tcp (In high-time engines)[a] Grade 115/145 4.6 cc tel	372	363	51	34	16	1	13.7	13.4	9.1
0.8/0.2 (In low-time engines)[a] Grade 115/145 4.6 cc tel	329	117	11	7	4	0	3.3	3.3	2.1
1.0/0.1 Grade 115/145 4.6 cc tel	666	210	36	16	8	12	5.4	3.6	2.4
1.0/0.2 Grade 115/145 4.6 cc tel	397	115	9	6	2	1	2.3	2.0	1.5

[a] For six weeks prior to starting of testing, all aircraft were grounded for structural reasons. During this time all engines were in temporary preservation. The preservative oil appears to have strongly affected plug fouling particularly in high-time (over 300 hr) engines.

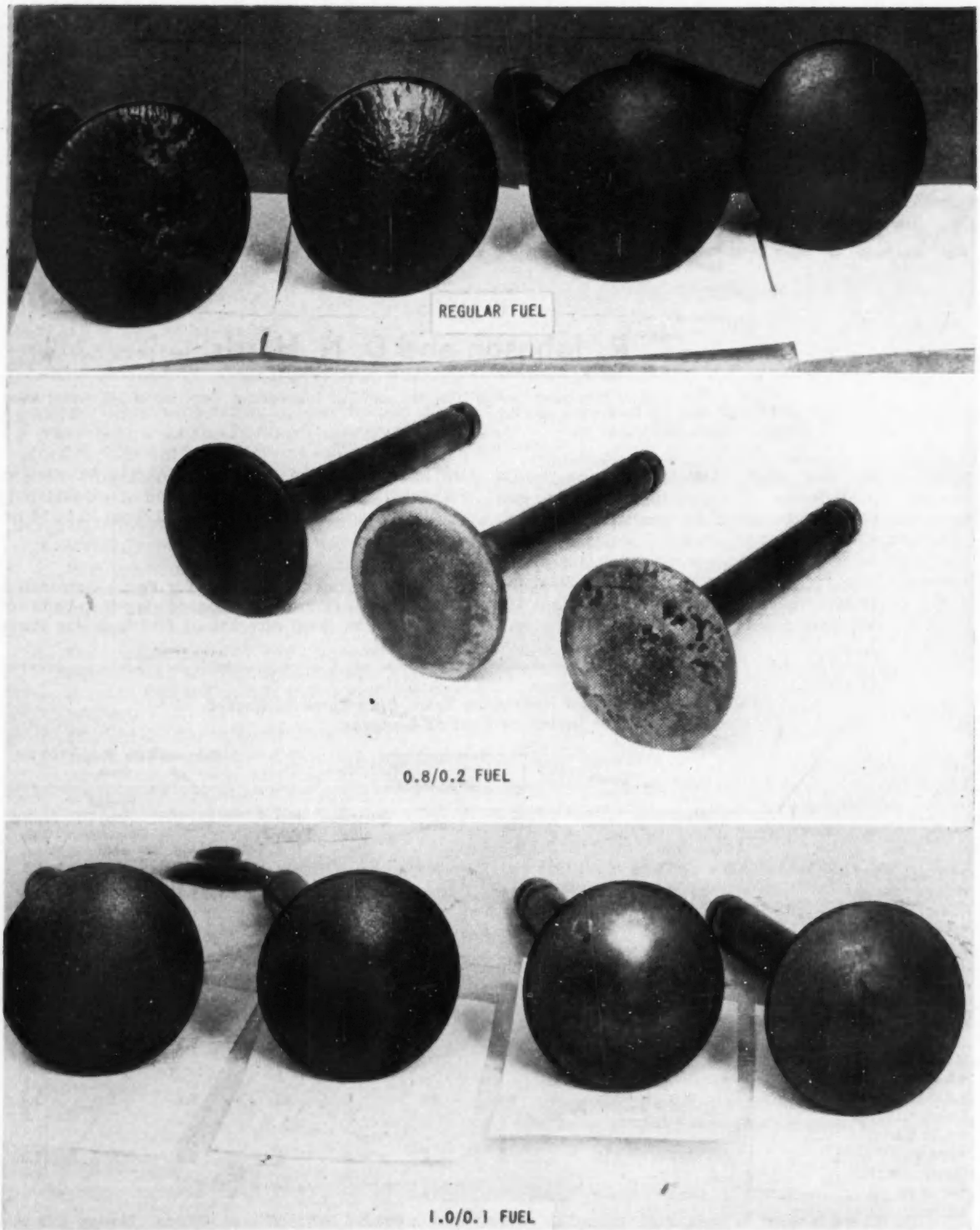


Fig. 2—Amount of deposits on valve crowns does vary with fuel type used, these illustration valves taken from engines of B-36 aircraft show. It's fairly obvious that the fuel with the 1.0/0.1 scavenger produced the least deposits

Base. Initial tests were limited to one airplane. This test was conducted on a D series aircraft equipped with R-4360-41 engines, operated for long periods at high bmep and ultra-lean fuel/air ratios.

Unscheduled spark-plug removal was based on observation of the airborne ignition analyzer. New AC-281 spark plugs were used and normally changed each 100 hr. Due to relatively high power cruising operation, average time between overhauls was relatively low.

Inspection of engines and accessory equipment at overhaul indicated the components to be in normal condition, except as follows:

a. Combustion chamber and exhaust valve tulip deposits were somewhat heavier than normal. Typical valve crown deposits are shown in Fig. 2.
b. Heat exchanger deposits were somewhat heavier than normal.
c. Exhaust turbo deposits also were slightly heavier.

Although these deposits did not cause any malfunctioning, it was considered desirable to reduce the deposit level. Since spark plug performance was considerably improved, determination of the minimum permissible TCP level appeared desirable.

So tests were started on a 1.0/0.1 fuel. Since this fuel could be field blended using a TCP concentrate, the experimental fuel handling facilities bottleneck was eliminated. Four aircraft were used, including the new F model powered by the -53 engine.

Table 2—Summary of B-36 Spark-Plug Fouling Rates

Engine	Fuel	Plug Fouling Rate/100 Hr	% Reduction in Unscheduled Plug Removals
R-4360-41	Regular (1.0)	7.2	
R-4360-41	0.8/0.2	0.73	89
R-4360-41	1.0/0.1	2.43	67
R-4360-53	Regular	1.41	
R-4360-53	1.0/0.1	0.36	75

Inspection of engines and components at overhaul indicated that the change in scavenger composition was effective in reducing deposits. Examples of crown deposits are shown in Fig. 2. Heat exchanger and exhaust turbo deposit levels were quite comparable to those obtained with regular fuel.

Table 2 gives a summary of spark-plug performance.

Due to the type of operation involved in the R-4361-41 tests on 1.0/0.1 fuel (training of new crews), examination showed that some 68 of the 89 plugs removed probably were not fouled. Excluding

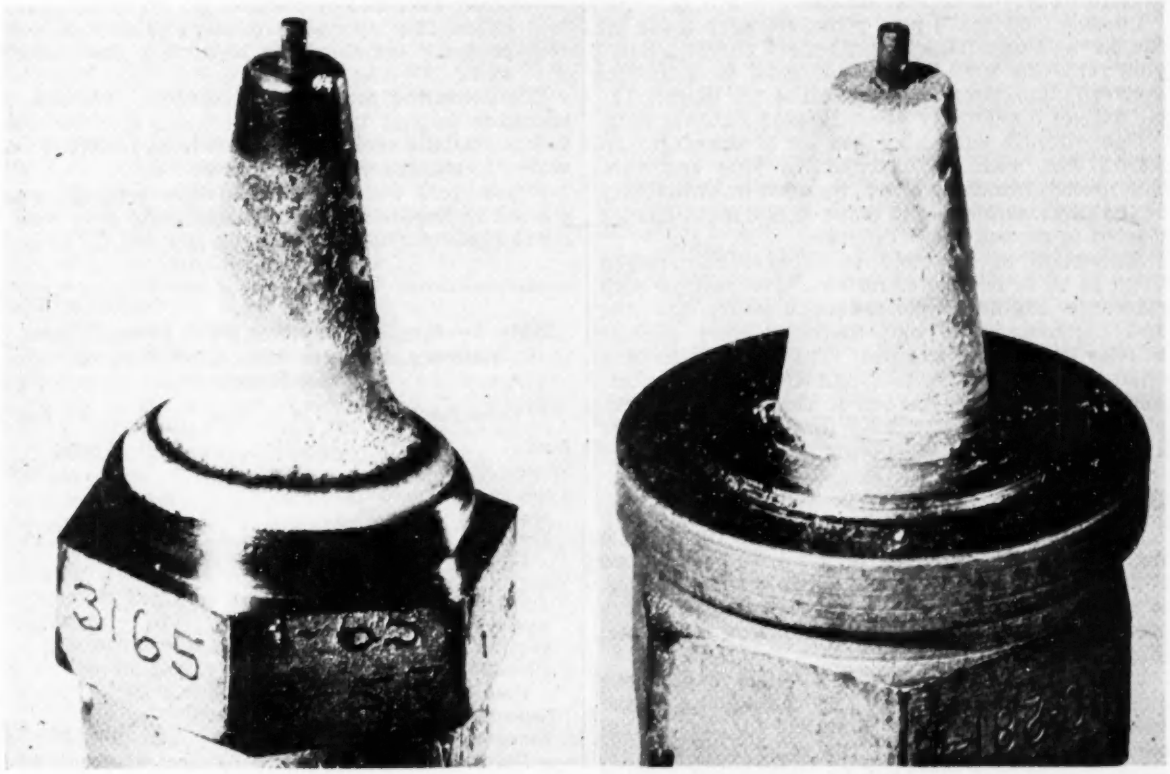


Fig. 3—These spark plugs were operated in R-4360-41 engines on B-36 aircraft. The plug at left, which is fouled, shows a typical glazed deposit on the core nose when operated with regular gasoline. The plug at right is typical of results obtained with TCP fuel

Table 3—Summary of F8F Unscheduled Spark-Plug Removal Data

Engine	Fuel	Removal Rate/100 Hr	% Reduction in Removal Rate
R-2800-34W	Regular (1.0)	26.0	
R-2800-34W	0.8/0.2	3.4	87
R-2800-34W	1.0/0.1	14.9	43

these would raise the reduction from 67 to 92%. The true figure probably lies in between, in the order of the 75% found on the -53 engines. Typical spark-plug insulators are shown in Fig. 3.

On completion of this work, the program was expanded to include the operation of all aircraft at Carswell. After five months of service experience, a survey of flight and maintenance crew experience indicates that prediction of improvement in spark-plug operation is being realized.

Fighters

The Navy Bureau of Aeronautics evaluated TCP in F8F aircraft operated in the Naval Air Advance Training Command. Four aircraft having low engine time since overhaul were operated on 0.80/0.2 fuel for 240 hr. Following this phase, 1.0/0.1 fuel was used for a second period of 240 hr. On completion of this second phase, two engines reached their normal overhaul. They were removed for inspection along with two engines from reference aircraft in parallel service on regular fuel.

Unscheduled spark plug removals were made on the basis of unsatisfactory magneto checks. Some plug removals were on an individual basis, others involved changing one half or all of the plugs. Table 3 gives a summary of spark-plug removal data.

One aircraft completed 295 hr of operation on 0.8/0.2 fuel with no unscheduled plug removals. The records indicated a 20% increase in availability of the test aircraft due to reduced line maintenance needed to correct rough engines.

Inspection of the engines at overhaul showed them to be in normal condition. Comparison with reference engines indicated combustion chamber and exhaust valve tulip deposits were slightly heavier on the test engines. This appears to be a characteristic of TCP, although so far it seems unrelated to the performance of those engine parts.

Following this test, 1.0/0.1 fuel was supplied for all training units in the Corpus Christi area.

DC-6's

In November, 1951, American Airlines initiated a flight evaluation program of a 1.0/0.2 fuel in two R-2800 powered DC-6 coaches. To our knowledge, it is the first actual full-scale commercial service test of an experimental fuel conducted in normal airline operation.

This test was initiated with engines in positions 1 and 2 operated on regular fuel and 3 and 4 on the test fuel. Four engines operated to the normal overhaul time of 1100 hr; the other four engines were prematurely removed for causes not related to the test program.

Operation was with R-37S spark plugs, low tension ignition, 20-deg spark advance, and a cruising fuel/air ratio of about 0.072 obtained by a 2-3 bmep drop carburetor lean out.

Results of this test are summarized in Table 4, showing unscheduled spark-plug and cylinder removals. Although total incidences of spark-plug removals are listed, the more pertinent figures are believed to be the cases where only plug changes were necessary to correct the reported trouble.

The rate reduction of about 30% through the use of TCP is somewhat less than was expected. It is thought to be due to the relatively rich cruise fuel/air ratios used on these engines at this time. A 30% reduction in unscheduled cylinder removal rate was noted on the test engines. The reason for this reduction is not now apparent.

Inspection of engines at overhaul indicated the test and reference engines to be similar, with the following exceptions:

a. Combustion chamber deposits were slightly heavier on test engines, particularly in the cylinder head recesses and exhaust port areas. Some idea of this difference is shown by the exhaust valve deposits based on 1000 hr time, which averaged 5.2 g on the reference engines versus 7.9 g on the test engines.

b. Compared with the reference engines, increased corrosion was observed on some, but not all, of the exhaust valve crowns.

Examination of the severely corroded valve crowns by the valve manufacturer indicated that the carbides in the outer layer are selectively attacked by combustion products. This causes this layer to exfoliate, leaving corrosion products between this layer and the normal metal.

The confusing factor with respect to this severe corrosion is that it occurred on only part of the valves. Additionally, it has not been observed on valves in the other test programs.

Phase II of this flight evaluation program was started in September, 1952. Conditions were similar to those of Phase I, except in the interim to im-

Table 4—American Airlines DC-6 Phase I Tests. Summary of Unscheduled Spark-Plug and Cylinder Removals

Engine Position	1	2	Total	3	4	Total
Fuel	1.0	1.0		1.0/0.2	1.0/0.2	
Engine Hours			4400			4382
Total Incidences of Unscheduled Spark-Plug Removals	6	9	15	9	3	12
Rate/1000 hr			3.4			2.7
Total Incidences of Unscheduled Spark-Plug Removal Without Other Ignition Changes	5	4	9	4	2	6
Rate/1000 hr			2.0			1.4
Unscheduled Cylinder Removals	8	16	24	8	6	14
Rate/1000 hr			5.5			3.7

prove general engine performance, the following changes had been made:

1. Climb powers were reduced 50 to 100 bhp with rpm changes.
2. Cruise rpm was changed.
3. A colder spark plug (R-33) was installed in the front row, rear position.

This test was initiated on 1.0/0.1 fuel, since at this time this scavenger composition appeared optimum in other tests. The program was expanded to include eight airplanes in coach service. Additionally, a 7 bmep (corresponding to 0.066 fuel/air ratio) lean out during cruise was adopted for these aircraft. Relatively few hours have been accumulated on this engine.

Results accumulated to date are shown in Table 5. Fouling rate based on plug change data only is again indicated as a 30% reduction with TCP. In this connection, considerable trouble has been experienced by the flight crews in holding fuel flows due to the contours of the manual leaning disks installed on these aircraft. It is doubtful just how much of this operation has been at the leaner cruising condition. These results may not therefore be representative. Efforts are being made to modify the manual leaning disks to improve this control condition.

Table 5—American Airlines DC-6 Phase II. Summary of Unscheduled Spark-Plug and Cylinder Removals Total Engine Hours—14,664

Engine Position	1	2	Total	3	4	Total
Fuel	1.0	1.0		1.0/0.1	1.0/0.1	
Total Incidences of Spark Plug Removals	8	3	11.5	4	9	13
Rate/1000 Hr			1.5			1.78
Total Incidences of Spark-Plug Removal Only Without Other Ignition Changes	6	1	7	3	2	5
Rate/1000 Hr			0.96			0.68
Unscheduled Cylinder Removals	3	8	11	1	3	4
Rate/1000 Hr			1.5			0.54

Convair 240's

KLM Royal Dutch Airlines completed tests on two R-2800 engines in Convair 240's normal commercial service. One engine failed mechanically at 686 hr due to causes unrelated to the test. The other engine completed operation to a normal overhaul. During the first 600 hr operation, 1.0/0.2 fuel was used; during the last 600 hr, 1.0/0.1 fuel was used.

Engine operation during cruising was 85 to 90% at 1000 bhp, with an 8 bmep drop giving a fuel/air ratio of 0.065.

The 60% reduction in unscheduled spark-plug removal rate achieved in these tests is in line with military tests. The 600 versus 420 hr figures for normal life are presumed to be based on the 200-hr inspection without replacement, which differs from the normal practice in this country.

Stratocruisers

In September, 1952, Northwest Airlines started a service test of 1.0/0.1 fuel in its Stratocruiser fleet. Two factors led to the undertaking of this evaluation: (1) the experience of high spark-plug fouling rate in this equipment, and (2) successful operation of B-36 aircraft on this fuel.

The test was suspended after some two weeks because of increased exhaust turbo back pressure required to maintain manifold pressure. Further investigation revealed excessive deposits on the exhaust turbo. These deposits were sufficient to produce a significant reduction in exhaust turbo efficiency.

An active laboratory program now is under way to duplicate, and attempt to solve, the deposition problem experienced in the 377 Stratocruiser.

Constellations

Trans World Airlines undertook flight tests on half of their Constellation 049 coach fleet in June, 1952, using 1.0/0.1 fuel. These tests were concluded after accumulation of three engines operated on this fuel to their normal overhaul time of 1100 hr.

These engines were operated with a bmep drop of 10% of the best power bmep during cruise, which is quite lean for commercial operation. Spark-plug removals were, as necessary in commercial operations, based upon "flight squawks" recorded in the aircraft logs.

Looking at a purely numerical summary of the data, one sees a discouraging picture. Apparently TCP has not improved operation. In fact, it has increased some of the chronic troubles, such as unscheduled cylinder removals. Further study of this operation indicated that both unscheduled spark-plug removal and cylinder removal rates are a function of engine time since overhaul. It was also noted that often spark plugs were removed for reasons which appeared unrelated to spark-plug fouling, such as high cylinder-head temperatures.

Therefore, these data are being reprocessed through an engineering evaluation. Results of this study are not yet complete.

In summary, certain characteristics of the entire TCP test programs are worth mentioning.

For one, accumulating accurate performance data on spark plugs can be accomplished, but with considerable effort, on aircraft operating from a given base and being refueled and maintained at that base. This task becomes most difficult on aircraft operating through, and being refueled and maintained at, many bases for two reasons:

1. The problem of collecting complete and accurate records.
2. The variable habit patterns of mechanics with respect to replacement of spark plugs.

Spark-plug malfunctioning has normally been considered primarily as a contributor to operating delays and costs. In the light of recent information, TCP's role in what has been considered normal high-power, level engine operation appears worthy of continued investigation.

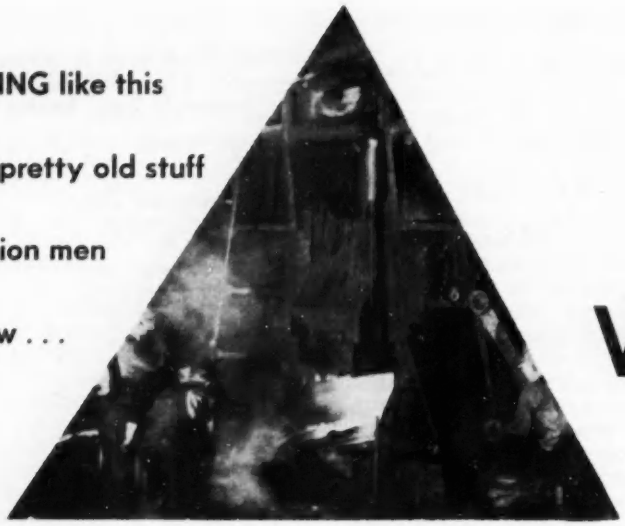
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DROP FORGING like this

is pretty old stuff

to production men

who want to know . . .



What's

WHAT's new in the forging industry today? This is what production men came to this session to find out . . . and they did! They learned the latest on:

- Improvements in forging process
- Automation
- Chambersburg impacter
- Furnaces
- Forging dies
- Cold forgings
- Statistical quality control

Improvements in Forging Process

There has been real progress with design of forging tools, though little change in basic hammer designs. Hammers are designed more rigidly than in the past.

Automatic controls for handling and heating stock have materially increased production.

Furnace design has been improved considerably. Pusher and rotary type furnaces have come into more general use.

Gas is used more for heating. Induction heating, too, is more widely used than in previous years. Proper heating facilities have considerably reduced scale, but there is still room for improvement.

Rolls recently developed for preforming stock are believed to save hammer or press operations.

Constant redesigning of forging presses is saving material and labor, and increasing production. A tong-feed forging machine under development will be automatic and probably will increase production.

Automation

New methods for handling hot metal from furnace to forging machine aim to eliminate the human element in handling stock. There are many problems to overcome. For example, large amounts of scale make use of mechanical contrivances difficult. In some instances, high-speed movies are being used to study automatic handling. Purpose is to determine what type of equipment can and should be used.

Secret of the success of automation in the forge shop lies in the continuity of the product and the length of run of the piece to be forged.

Chambersburg Impacter

The Chambersburg impacter is a new approach to material handling problems—one that demands certain changes in die design. It also requires that each job be specially engineered to insure that the stock will be properly located between the two moving dies.

Minor problems are experienced when forgings stick in the dies or when more than one blow or pass is needed in the impacter.

Furnaces

High-speed gas heat has been extremely helpful in increasing production of certain forgings. Here, reduction of scale has proved an important question.

Induction heating and automatic controls are fast eliminating manual responsibility and assuring more accurate results. Use of induction heating where practical and suitable means less material used and increased production. Induction heating also gives less smoke, provides cleaner shop operation through elimination of gases, and increases die life. Main objection to induction heating is the initial or installed expense.

Die life has been increased with use of induction heating for upsetter jobs.

In some instances, size or weight of forging stock

Ahead in Forging

Raymond Seabury, Drop Forging Association

Based on secretary's report of Panel on Forgings held as part of the Production Forum at the SAE National Production Meeting, March 25, 1953. Panel Leader was C. H. Smith, Jr., Steel Improvement and Forge Co.

limits the use of induction heating. For that matter, size or length of run has much to do with savings realized with induction heating.

Whether rotary furnaces or pusher-type furnaces are used depends on work to be done and available space. Both types of furnace seem to be very efficient ways to heat stock.

Some jobs require that stock be preheated before bringing it up to forging heat. Little advantage in scale elimination or grain structure seems to result from preheating.

Forging Dies

Multiple-spindle die sinking machines are helping to solve the manpower problem (shortage of journeyman die sinkers). Little difficulty is being experienced with differential cutter wear on these machines if die blocks are of uniform hardness. Where hardness varies, uneven cutter wear causes trouble.

Some plants recently have been experimenting with the casting method for putting impressions in die blocks. So far it has been impossible to hold the impressions to proper tolerances.

Cold Forgings

There seems to be a definite trend from hot to cold forgings. Many new and better steels are encouraging this, as is the fact that die life is increased considerably with cold forging.

Cold forging requires a machine at least five times as large as is needed for hot forging. The process is used mostly for bolts, nuts, and so forth, rather than for a general line of commerical drop forgings.

Initial investment for cold-forging machines is considerably more than for hot-forging equipment, but production output is greatly increased. Therefore, where adaptable, the additional capital investment seems to be worthwhile.

Experiments with cold forgings are continuing and limitations at the moment are unknown. Changes in designs or dies may increase size of stock that can be worked cold in the future. One-inch stock seems to be about the limit today.

Higher carbon steels do not lend themselves too well to cold forging. Some experimental work is being done on production of jet blades and pinions by cold forging.

Statistical Quality Control

Several large plants, particularly long-run automotive shops, find statistical quality control extremely useful for controlling such things as weight, straightness, length, and heat treatment. Statistical quality control stations throughout plants also help materially in reducing scrap and lengthening die life. Quality control charts set up at hammers help hammermen eliminate imperfect forgings. Some plants go so far as to use quality control in steel yards for checking stock length. This has worked out particularly well for bars cut to length for use in upsetting machines.

Discussion of quality control brought out the need for grading stock according to tolerance before cutting. This is especially true where tolerances vary slightly in diameter. Such grading or checking before cutting results in improved die life.

(The report on which this article is based is available in full in multilithographed form together with reports of the seven other panel sessions of the Production Forum held at the 1953 SAE National Production Meeting. This publication, SP-301, can be obtained from SAE Special Publications Department. Price: $1.50 to members, $3 to nonmembers.)

Synthetic Fibers

• What they contribute

WE are in an era of a luster revolution made possible by new man-made fibers which are essentially ideal for use in automobile upholstery fabrics. There never was a time in the building of automobiles when the ultimate consumer has received as much service and style appeal from the fabrics used in upholstering and decorating as he does at present.

To the three principal upholstery fibers—cotton, wool and mohair—have been added fairly recently and to limited extent, acetate and viscose, and more recently Nylon and Orlon. More than 70 entirely new fibers have been produced in laboratory or pilot plant quantities. The eight synthetic fibers now offered, or soon to be offered, in commercial quantities include Dacron, Dynel, Acrilan, X-51, Perlon, Kuralon, Saran and Vicara. Others, now in the development stage, are due to make their appearance in the next few years. None will be adopted because it is new or described by publicity men as "wonder fibers" or "miracle fibers." Each will have to prove its worth before acceptance.

There is no universal fiber, none which answers the purpose of the stylist and textile engineer in all particulars. Each fiber, including the natural ones, has individual characteristics of outstanding merit, but for one reason or another none is suitable alone for all textile applications. Then, too, it has been found that combinations of these fibers yield properties not possessed by the individual fibers.

The number of possible mathematical combinations of fibers is large. If the five older fibers, plus the two newer ones and the eight synthetics on the way, are combined as 2-fiber mixtures, 105 different combinations are possible, whereas with 5-fiber mixtures the number rises to 3000. If one considers in addition the various forms in which the synthetics are available, the several methods of preparing yarns, the varying of fiber percentages within the yarns, the many fabric constructions and methods of dyeing and finishing, the total combinations and variations becomes practically infinity.

Obviously, the stylist and fabric manufacturer must have an intimate knowledge of the merits and faults of the individual fibers if they are to handle them intelligently and build the required properties into the fabric. Here, then, are some of the outstanding characteristics of the individual fibers:

Nylon

This polyamid fiber is available both as staple and filament. It is notable for high tensile strength and resistance to abrasion. It is highly elastic, recovers well from stretching, does not shrink, washes easily and dries quickly, has excellent resistance to mildew and insects, and resists burning well. Low water absorption has made good fastness to light fading a problem, but special dyestuffs are overcoming the fault. Price is high but stable, supply is fairly good and rising. Widely used in automotive fabrics.

Orlon

The one acrylic fiber derived wholly from acrylonitrile. Has superior resistance to sunlight and excellent bulking power. It exhibits good wrinkle resistance and crease recovery, and has satisfactory wear resistance. Easy to wash and dries quickly because it is even more hydrophobic than Nylon. It does not shrink, has good draping quality and is warm to the touch. It is difficult to dye and this property has been used to achieve pattern effects. Price high but stable, and supply moderate and rising.

Dacron

A polyester having superior wrinkle resistance, crease recovery and unusual resilience. It has very little stretch, ranks next to Nylon in tensile strength,

• How they are used to make finer upholstery fabrics

W. F. Bird
Collins and Aikamn Corp.

G. P. Carver, Jr.
Bachmann Uxbridge Worsted Corp.

Based on two papers "The Luster Revolution" by Bird, and "Fabric Selection and Fabrication of Man-Made Fiber Automotive Cloth" by Carver, presented at SAE National Passenger Car, Body, and Materials Meeting, Detroit, March 4, 1953.

and possesses excellent resistance to abrasion and wear. Exposure to sunlight degrades it slightly, but it has good resistance to mildew and is not attacked by moths. It drapes well, is warm to the touch, and washes and dries easily because it is the least absorptive of all fibers. This explains why it is difficult to dye. However, finding of a new class of dyestuffs makes it possible to produce shades comparable with the best vats on cotton. Price is high, but stable. Supply small and not available in even moderate quantities before early 1954.

Acrilan

An acrylic fiber. Like Orlon and Dynel is has superior bulking power, good wrinkle resistance and crease recovery. It has fair wearing quality, good resistance to sunlight, acids, mildew and insects, is easy to wash, dries quickly, and does not shrink. It drapes well, is warm to touch and has fair resilience. Dyes more readily than Orlon, but there is still much to be desired. Physical characteristics and dyeability are being improved steadily. Price high, but stable. Supply small, but will increase rapidly if and when properties become stabilized. Available only as staple.

X-51

The acrylic with the best dyeing characteristics. Has remarkable wrinkle resistance and crease retention even when wet. It has good wear resistance, drapability, and resistance to insects, mildew and chemicals. Its soil resistance is superior and it washes and dry cleans readily. Drying is quick because of low water absorption. Like Orlon and Acrilan in resilience, but a somewhat softer fiber. It is warm to touch. Still in pilot plant stage and supply small. Expected to be in production in two years. Price high but stable.

Perlon

A polyamide very similar to Nylon. Now imported but within a year and a half at least two manufacturers will be producing it domestically. It has high tensile strength, resilience and melting point which very nearly parallel those of American Nylon with which it is competitive in price.

Dynel

Classed as an acrylic fiber. Superior resistance to burning and little affected by acids and chemicals due to 60% vinyl chloride content. It has good bulking power, wrinkle resistance, crease recovery and drapability, with moderate wear resistance. It is warm to touch, washes easily without shrinking, but does shrink with heat and must be processed at low temperatures. Shades of modern depth with fair light fastness may be achieved by

Why Cloth Makers Have Nightmares

The cloth manufacturer tries to guess what the trim styler and trim engineer will like. They in turn try to guess what the sales manager, the president and all the vice-presidents will like. These, in turn, try to guess what the public will like—and goodness knows what the public will like, as it doesn't itself know.

You can take a plain piece of cloth, trim it with pleats or buttons and make a neat looking job. You can also take a strongly striped fabric, or even a check, and trim it plain and make it look well. But do we who are supposed to design the cloth and get new effects ever know how the cloth is to be trimmed? We do not. We don't even know what color the outside paint will be. Yet we are supposed to make up samples at great expense, dye them in suitable colors, and come up with a cloth that will fit into an unknown trim scheme, please unknown people, and fit an unknown price class.

After we have made up a sample that is liked by the trim engineer or a styler, we are then told in what price class it should be, how wide and in what color. So we start all over again.

We make thousands of samples a year for the simple reason that if we show enough we are bound to have a few that will please. This is all hit or miss, all very expensive, and all very unbusinesslike. In the last analysis it adds to the price you must pay for the cloth. We could do a much better job if you would give us more guidance.

conventional means, but heavy shades require special dyeing technique. Price moderate and stable. Supply fair and increasing. A more heat stable type with properties more like Orlon will soon be available.

Kuralon

A Japanese fiber derived from polyvinyl alcohol. More like cotton than wool, but remarkable for abrasion resistance. It is available only as semi-dull staple and 100% Kuralon fabrics lack character. Dyes readily with most classes of dyestuffs, but light fastness in general is not good. Price moderate, supply small.

Saran

A polyvinylidene chloride fiber also marketed under the name Velon. Is sold mostly as monofilaments and is made in small quantities as 10d and 22d/f staple and tow. It has been used alone and with wool in the manufacture of carpets. The monofilaments are used for seat covers. It is practically flameproof. Difficult to dye, hence both monofilaments and multifilaments are usually dyed by adding color bodies to the hot melt before extrusion. Cost per pound is moderate, but high density makes coverage per pound less than that of other fibers.

Vicara

Derived from Zein, the corn protein. Superior in softness, hand and draping quality, and dyes well in a wide color range. New forms have good dimensional stability despite high moisture absorption. It blends well with other fibers and usually improves spinability, adds softness and improves the hand. Wet strength is low and to offset this it can be blended with stronger fibers. Price moderate and stable. Supply moderate and rising rapidly.

Fabrication, then, is building a piece of cloth suitable for the purposes intended as well as for the style or trend of the market and at a price that will sell. In the last few years the swing has been to man-made fibers for auto cloth use, because some of the fibers, such as Nylon, are so strong and so abrasion resistant that they are ideal for upholstery.

For example, the woolen system cloth usually has a warp tensile strength around 50 lb and a filling strength of about 45 lb. The newer man-made fiber cloth such as a Nylon warp and a cotton filling will

break in the warp at over 250 lb (many of these cloths cannot be broken on our existing testing machines) and the filling, being cotton, because of construction will break at around 100 lb.

The abrasion resistance of such cloth is even more dramatic than its tensile strength. And one must add to this the finer construction which the synthetics make possible, constructions which give style effects never before possible at such a low price.

Most synthetic fibers are made in one or two degrees of fineness suitable for auto cloth construction. They are uniform, they spin as fine as yarn equipment will go or as fine as is necessary for the type of fabric one wants to produce. They all spin well, so the fineness of the fiber, the yarn and the construction is not as costly as it used to be on the woolen or worsted system using woolen wools or worsted wools.

The price of woolen and worsted wools will vary from dear to dirt cheap while the synthetics have remained constant in price over long periods. The history of rayon and acetate shows that as consumption increases the price trend is definitely downward. If, therefore, it is decided that synthetics are superior for auto cloth, we can look for a gradual reduction in raw material cost as consumption increases.

Today the price of a woolen fabric is about the same as that for a man-made fiber fabric, but the latter fabric has twice the value, based on serviceability. All our laboratory tests show that the synthetic fabric should outwear the woolen type about 10 to 1. Probably it will outlast the car. Certainly, most of the medium or low priced woolen cloths will not last the life of the car.

(Papers on which this abridgment is based are available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ each paper to members; 50¢ each paper to nonmembers.)

Based on Discussion

Questions answered by Mr. Bird

Q—What is the difference between wool manufacturing and worsted manufacturing?

A—In a worsted yarn a longer staple raw material is used and all processing is designed to parallelize the fibers. Due to the longer staple and parallelization, worsted yarns are generally more sleek, less bulky, and can be spun to much finer counts than woolen yarns.

Q—Which system are we using in synthetic manufacture —wool or worsted?

A—Both systems, depending upon the quality and effects desired in the finished fabric.

Q—What is the difference in strength between spun and filament yarns, and what is the comparison in cost?

A—It is impossible to give a standard strength comparison. The comparative strength will depend upon the type of raw material, resulting count and resulting twist. A plied or twisted filament yarn might be somewhat stronger than a spun yarn, particularly if made of Nylon. Filament yarns of acetate, viscose, Nylon, Dacron and Orlon would be much more expensive than spun yarns.

Questions answered by Mr. Carver

Q—What do you think of Orlon for convertible tops and can it be suitably dyed for this purpose?

A—About two years ago lengthy experiments with Orlon failed to get a satisfactory piece of cloth due to the shrinkage or stretch of the yarn. The pieces were streaky or barry in both the warp and the filling. We found the only way it could be dyed suitably was in a pressure dye machine and we did dye some which was satisfactory in fastness to light. I feel more work will have to be done before Orlon is perfected for tops, but it will come in a matter of a few years.

Q—What is the chance to dope dye Orlon?

A—Both acetate and viscose rayon are being dope dyed in fairly large quantities and there is a possibility of manufacturing Orlon in this fashion. It is time consuming because large runs must be made of one color and the operation might not be flexible enough to meet the quick deliveries required.

Q—What can be done to keep Dacron from melting due to hot ashes from cigarettes or pipe?

A—The DuPont people advise pipe smokers not to wear a 100% Dacron suit. Blending as little as 25% of flammable viscose rayon with Dacron will prevent melting in the manner of the 100% Dacron cloth. Adding wool will overcome this melting to a large degree.

Designers Choose Wing

K. E. Van Every, Chief, Aerodynamics Section, Douglas Aircraft Co., Inc., El Segundo Division

Excerpts from paper "An Engineering Comparison Using Straight, Swept, and Delta Wings" presented at the SAE Southern California Section, May 8, 1952.

ALTHOUGH it is impossible to select one planform for all high-speed applications, the swept and delta configurations offer speed advantages in the lower transonic range, and the delta offers the best possibility of achieving supersonic speeds with a given powerplant. At very high supersonic speeds a thin, low-aspect-ratio, straight wing may have some advantages.

With regard to handling characteristics, it is generally possible to make a relatively simple control system for the conventional straight-wing or swept-wing airplane, which employs a horizontal tail. The delta-wing airplane invariably requires the use of the more complex irreversible power controls. Some of the questions on the relative merits of the configurations can be answered only by flight tests. But others can be investigated by comparing hypothetical airplanes of the three planform types.

1. High-Speed Capabilities

For fighter aircraft, emphasis is placed on speed as the primary requirement, since a speed advantage is always necessary if a fighter is to perform its basic mission effectively. For slower airplanes such as transports and light planes the main factor in determining the high speed is simply the parasite or ordinary low-speed drag as shown in Fig. 1.

For airplanes having maximum speeds slightly less than Mach 1.0, the gains in performance can be achieved by increasing the airplane critical Mach number, or more exactly, the Mach number at which the drag rise occurs. This is illustrated in Fig. 2. Even supersonic airplanes should have a high critical Mach number, since much of the time they must fly at subsonic speeds in order to make the most efficient use of their fuel.

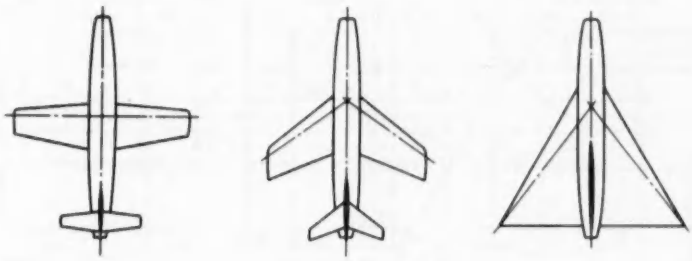
If we set our sights somewhat higher and ask for supersonic level-flight speeds, it is then necessary either to lower the peak drag coefficient, which occurs near Mach 1.0, or to obtain increased engine thrust. Obviously, there is a limit to engine size, and it therefore becomes necessary to lower the peak drag. The increase in maximum speed that can be achieved by this means is shown in Fig. 3.

If extremely high supersonic speeds are desired, that is, greater than Mach 1.2, the variation of drag coefficient with supersonic Mach number is the important consideration. This variation, shown in Fig. 4, is influenced by the type of planform and the airfoil section.

Thus, it is seen that for high-speed performance it is first of all necessary to devise an airplane configuration that will have the highest possible critical Mach number; second, if still higher performance is desired, the lowest peak drag coefficient; and third, if extremely high supersonic speeds are desired, decreasing drag coefficient in the supersonic region. Fortunately, the increase of airplane critical Mach number and lowering of airplane drag peak are achieved by the same three basic methods. These methods are illustrated in the next two figures. Fig. 5 shows that the critical Mach number may be increased by use of sweep, thinner airfoils, and lower aspect ratios.

Other means for increasing airplane critical Mach number, which are not shown in this figure, are combining components, such as wing, fuselage, tail surfaces, and canopy in an optimum manner and

Planform



according to

1. high-speed capability
2. handling characteristics
3. maneuvering characteristics
4. low-speed characteristics

the use of boundary-layer control. The drag-peak variation with sweep, thickness ratio, and aspect ratio is shown in Fig. 6. From Figs. 5 and 6, it can be seen that sweepback and reduced thickness are very powerful means of changing the airplane high-speed characteristics. Low aspect ratio is directly beneficial to some extent, but its major importance is in making possible reduced airfoil thickness.

From this it is apparent that an airplane designed to fly at high speeds can have widely different geometric characteristics, and it is only by considering all of the factors involved, including the operating-speed range, that the optimum airplane can be determined. In order to investigate briefly all the possibilities, three different, typical wing planforms have been selected and airplanes designed around

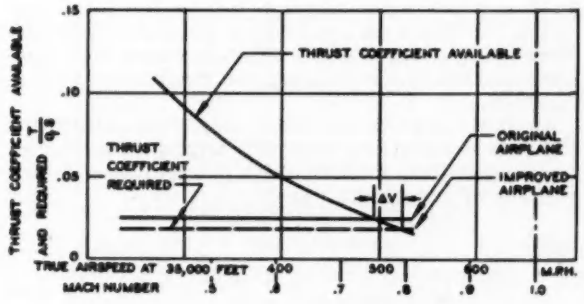


Fig. 1—Speed gain by reducing low-speed drag

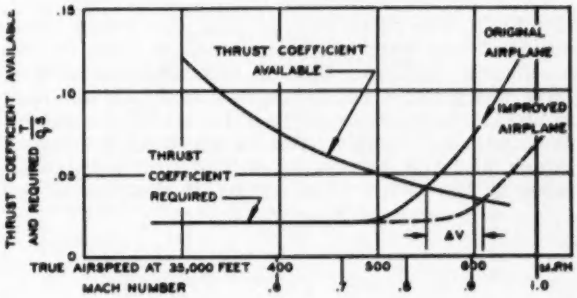


Fig. 2—Speed gain by increasing critical Mach number

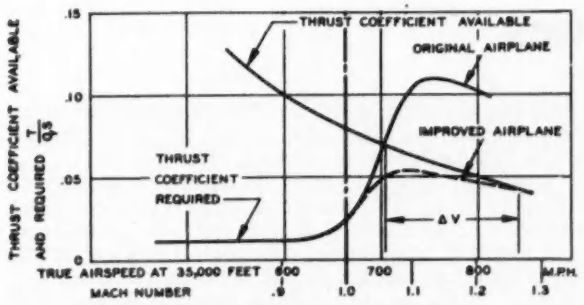


Fig. 3—Speed gain by lowering drag peak

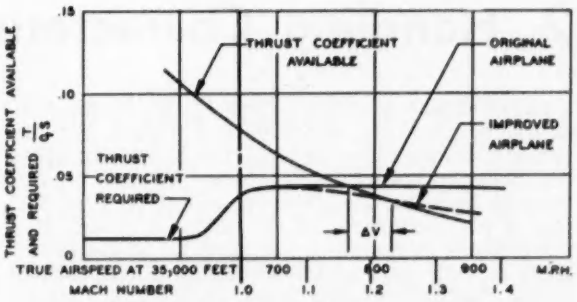


Fig. 4—Speed gain by variation of supersonic drag coefficient

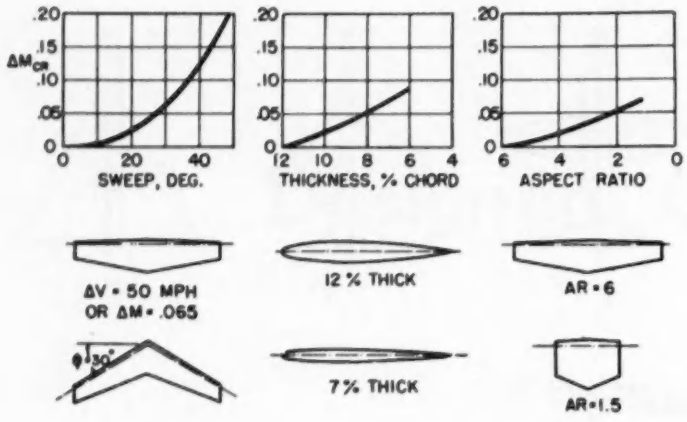


Fig. 5—Comparison of methods for increasing wing critical Mach number

them—all for the same basic mission and using consistent assumptions as to aerodynamic characteristics.

There are three types of planform to consider—a straight wing, a sweptback wing, and a delta wing. Examples are shown in Fig. 7. The straight wing has an aspect ratio of 5, and the swept wing is derived from it by rotating the wing panels 35 deg. This results in an aspect ratio of 3.4. The delta-wing configuration is a true equilateral triangle, which has an aspect ratio of 2.3. The areas of the different planforms are adjusted so that all of the airplanes have approximately constant stalling speed of 100 knots if the airplane gross weights are constant at approximately 15,000 lb. Now assuming for a minute that thickness ratio and area are constant, the drag characteristics are as shown in Fig. 8 for various Mach numbers.

These curves show that from a drag coefficient standpoint the delta wing is distinctly better than either of the other two planforms. It must be remembered, however, that if the airplanes are to have comparable stalling speeds and take-off distances the wing areas will be different. The straight wing will be smallest, the swept wing somewhat larger, and the delta wing will be nearly twice as large as the swept wing. Thus, if the product of drag coefficient and wing area is considered, the increased wing area will tend to cancel the advantages of the lowered drag coefficient. The problem, however, is complicated even more by the fact that it is possible to use smaller airfoil thickness ratios as structural span is reduced, without incurring a weight penalty. It is obvious that the ratio of structural span to maximum wing-root thickness is the same for the straight wing and the swept wing, but the percent airfoil thickness in the direction of flight is thinner for the swept wing. For the delta wing this same ratio is obtained if the wing-root thickness is approximately 5%. It should be pointed out, however, that other considerations such as torsional deflections and manufacturing difficulties also require a minimum thickness ratio of approximately 5% in order to make the design feasible. (See Fig. 7.) With the wing characteristics thus defined and the same fuselage for all the airplanes and if the airplanes are to have approximately the same flying characteristics and to perform the same basic mission, the resulting gross weights are nearly constant.

An indication of the high-speed capabilities at 35,000 ft is shown in graphical form in Fig. 10. It is apparent that only the delta configuration shows promise of supersonic speeds.

2. Handling Characteristics

Longitudinal Stability.—The static longitudinal characteristics are very little different for the straight and swept-wing airplanes in the low-speed region and at low angles of attack. An essential difference between the delta wing and the two airplanes having horizontal tail surfaces is that it is not possible to maintain a high value of static-stability margin and center-of-gravity travel because of the limited trimming power of the longitudinal-control surfaces. For example, if the same degree of static stability is provided in the delta wing as in the other two types of airplane, the usable maximum lift coefficient is reduced considerably.

Variation of static stability with Mach number (Fig. 10) is most pronounced for the straight-wing airplane. The stability usually tends to decrease as the airplane approaches its critical Mach number, then increase rapidly in the transonic region, and remain high at supersonic speeds. This large change in stability complicates the problem of con-

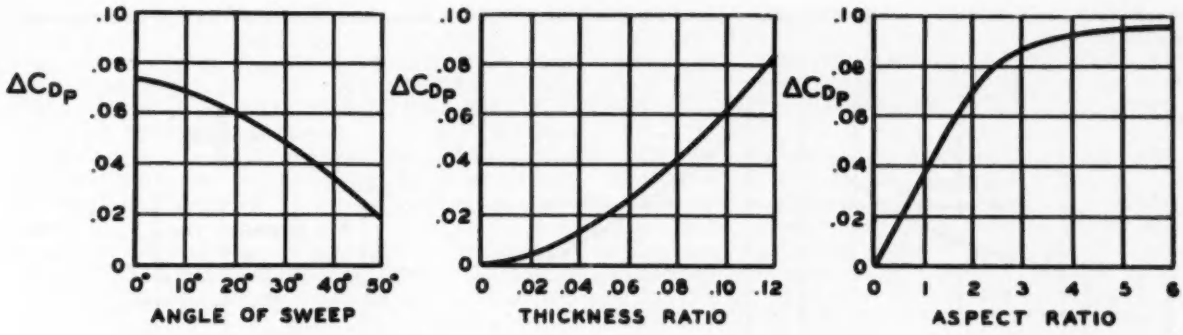


Fig. 6—Comparison of methods for lowering drag peak

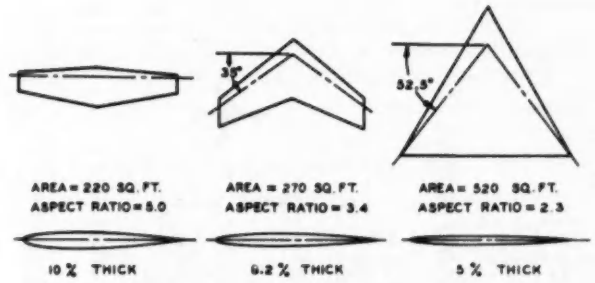


Fig. 7—Wing planform diagrams

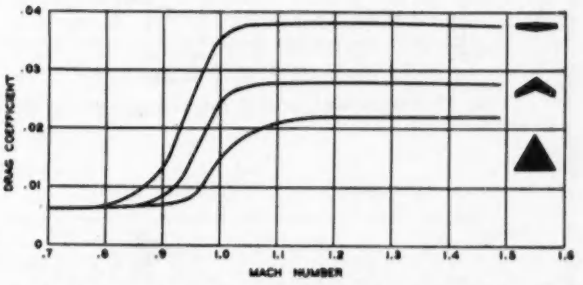


Fig. 8—Drag coefficient versus Mach number with constant airfoil thickness

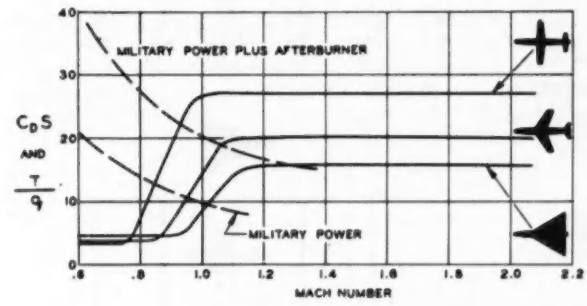


Fig. 9—Thrust available and thrust required

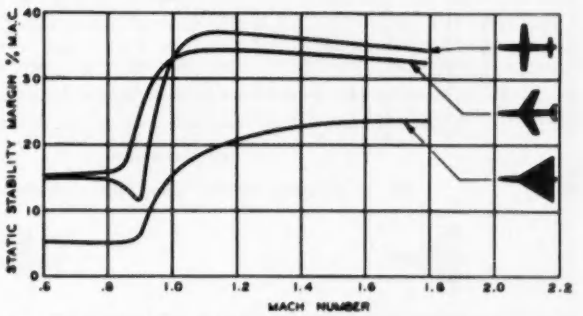


Fig. 10—Longitudinal stability characteristics versus Mach number

trol of supersonic airplanes and makes irreversible power controls almost a necessity if maneuverability is to be maintained at these speeds. The sweptback-wing airplane exhibits a similar trend of increased stability just below Mach Number 1.0, but usually fails to develop any loss in stability at high-subsonic speeds. The increase with Mach number is somewhat more gradual and of somewhat smaller magnitude than that of a straight wing. Both of these effects occur because a portion of the swept wing is always operating subsonically, even though the airplane speeds are supersonic. The delta-wing airplane shows the most gradual change in stability with changing speed, but even here the stability at supersonic speeds is several times that at subsonic speeds.

Dynamic-Longitudinal Stability.—One of the important differences between conventional airplane configurations with horizontal tails, such as either the straight or sweptback-wing configuration under consideration, and the delta type is that the conventional type actually increases longitudinal damping

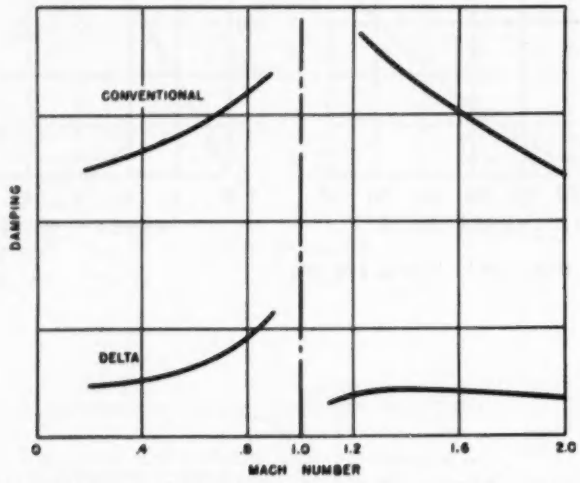


Fig. 11—Longitudinal damping characteristics versus Mach number

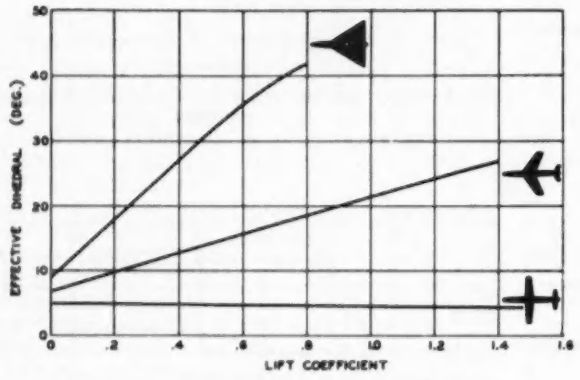


Fig. 12—Effective dihedral versus lift coefficient

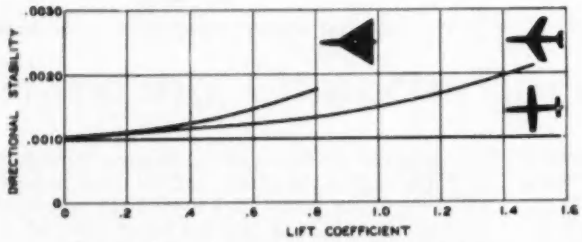


Fig. 13—Directional stability versus lift coefficient

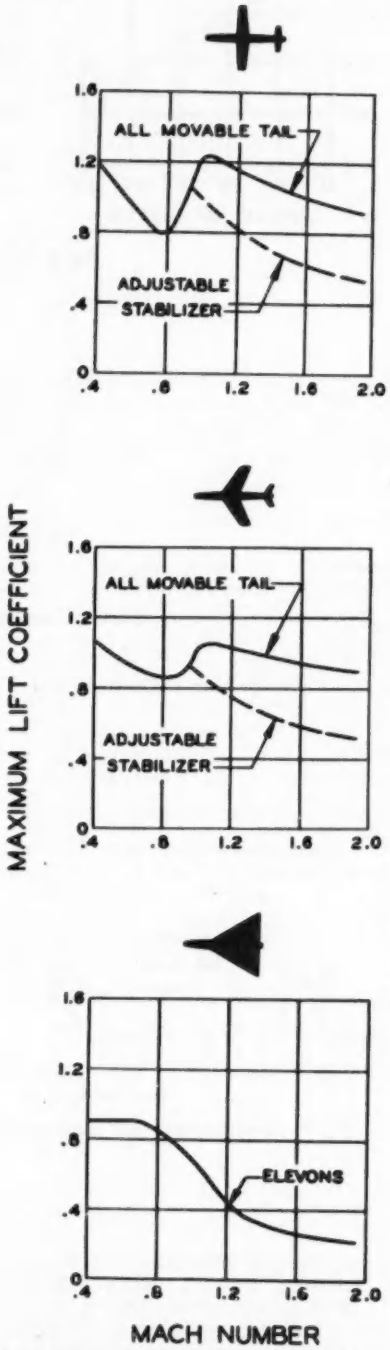


Fig. 14—Maximum lift coefficient versus Mach number

in the vicinity of Mach number 1.0, whereas the delta configuration tends to show a region of reduced damping at slightly supersonic Mach numbers. (See Fig. 11.) Although this condition is not known to be dangerous, it would have an adverse effect on the utility of the airplane as a gun platform or sighting station. Of course, cures for this type of trouble can be effected by the use of a longitudinal-pitch damper, to check longitudinal motions.

Lateral-Directional Characteristics. — Although objectionable lateral-directional characteristics or "dutch roll" oscillations may occur in any of the airplane configurations under consideration, the use of the swept or delta-type wing tends to aggravate this type of oscillation. The reason for this is shown in Figs. 12 and 13. The first of these shows that a straight-wing airplane has no variation in effective dihedral with lift coefficient, thereby making it possible to fit the configuration for a small amount of positive dihedral at high speeds and retain the effective dihedral throughout the speed range. In contrast, both the sweptback-wing and delta-wing airplanes exhibit a large increase in effective dihedral with lift coefficient. Thus, if a small effective dihedral is shown at high speeds, the effective dihedral at high lift coefficient or low speeds, or even high speed at high altitude, disturbs the normal relation between effective dihedral and directional stability.

Although the seriousness of the problem of lateral-directional oscillations can be minimized by proper choice of a configuration, conflicting requirements may make these choices impossible. Among the items that may improve the situation however, are minimum value for wing incidence and low-wing configuration. For most high-speed airplanes, it is necessary to resort to the use of a mechanical device known as a yaw damper, which essentially consists of a rate gyro that transmits a signal to a servo that operates the rudder in a direction such as to oppose the yawing motion.

Lateral-Control Characteristics.—At low speeds lateral-control characteristcis of a sweptback-wing airplane are generally poorer than those of a straight-wing airplane and about the same as those of a delta wing. At high speeds the delta wing's superiority is due to smaller wing twist.

3. Maneuvering Characteristics

The usable maximum lift characteristics differ considerably for the different airplane configurations as shown in Fig. 14. In general, the straight wing has the highest maximum lift at low speeds but exhibits the most rapid fall off with Mach number up to a value somewhat less than M = 1. The maximum lift coefficient then increases to its highest value just above Mach Number 1.0 and then decreases gradually. In the supersonic region the highest value is obtainable only if the airplane has an all-movable horizontal-tail surface.

Considerable trouble is experienced in attaining maximum lift if only adjustable stabilizer and elevators are available. The maximum lift coefficient of the swept-wing airplane is somewhat lower than that of the straight-wing airplane at low Mach numbers; it increases at low-supersonic Mach numbers and then decreases gradually with Mach num-

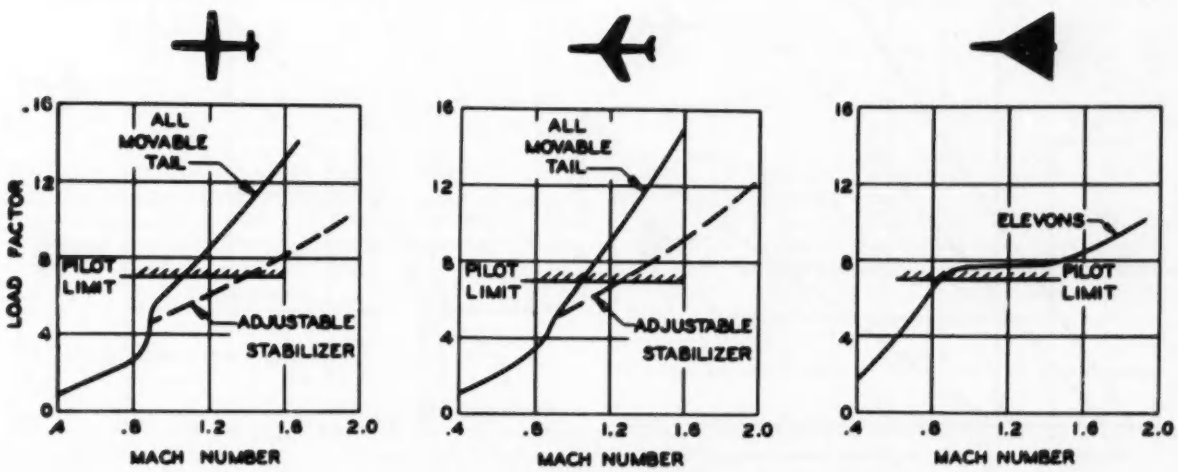


Fig. 15—Maneuvering characteristics

ber. Here again, the maximum values are obtainable only with all-movable horizontal-tail surfaces. The delta-wing airplane maintains a constant value of maximum lift coefficient throughout the major portion of the subsonic range, primarily because the maximum usable lift coefficient is determined by the trimming power of the longitudinal-control surface. This deficiency in trimming power results in the smallest value of maximum lift coefficient of all three configurations throughout almost the entire speed range.

Fortunately, the lower wing loading of the delta wing compensates for the lower value of maximum lift coefficient. Therefore for maneuvers in the transonic and supersonic ranges it is superior to the conventional airplanes. The load factors developed during maneuvers using these maximum lift coefficients are shown in Fig. 15.

4. Low-Speed Characteristics

Longitudinal Stability at the Stall.—One of the main problems of the sweptback configurations is that of obtaining a high value of maximum lift coefficient with flaps down, yet maintaining sufficient longitudinal stability so that the airplane will pitch down at the stall. The most effective method of solving this problem on swept-wing airplanes is to use leading-edge slats. This is usually not necessary on a delta-type configuration because of the very low aspect ratio and resultant three-dimensional flow around the tips. In fact, in a delta-wing configuration it is possible to modify the longitudinal stability at the stall by means of suitable small changes in planform. And as mentioned in the discussion of static-longitudinal stability, it is important to maintain a small but adequate static-stability margin in order to achieve the highest possible value of maximum lift coefficient.

Take-off and Approach Attitude.—The very low lift-curve slope for the swept and delta configurations requires a high-nose-up attitude to attain maximum lift coefficient. (See Fig. 16.) In the case of delta-wing airplanes, on which the use of landing flaps is impracticable, the situation is even worse. The required large increase in angle of attack makes the problem of visibility over the airplane nose a serious one and one that may be reflected in configuration changes that increase the drag at high speeds. For example, it requires the canopy to be placed far forward on the fuselage. The use of a high amount of wing incidence would, of course, be beneficial for this difficulty, but it aggravates dutch-roll oscillation during approach.

Sinking Speed.—The use of sweep and low aspect ratio automatically produces an increase in drag for a given lift coefficient at the speeds for approach and landing. (Fig. 17.) The result is higher sinking speeds and more difficulty in flaring during the landing procedure. This difference in landing characteristics may cause the pilot some concern. Probably the solution to this problem is to train the pilots to become accustomed to these new characteristics and to advocate the use of approach speeds somewhat higher than those now used.

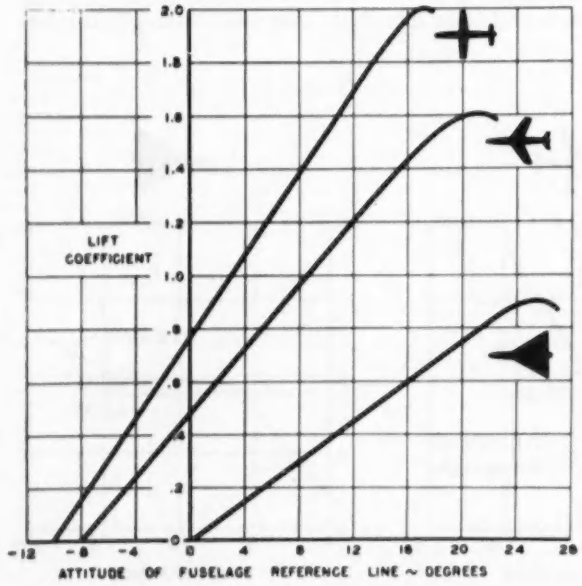


Fig. 16—Lift curves for landing configurations

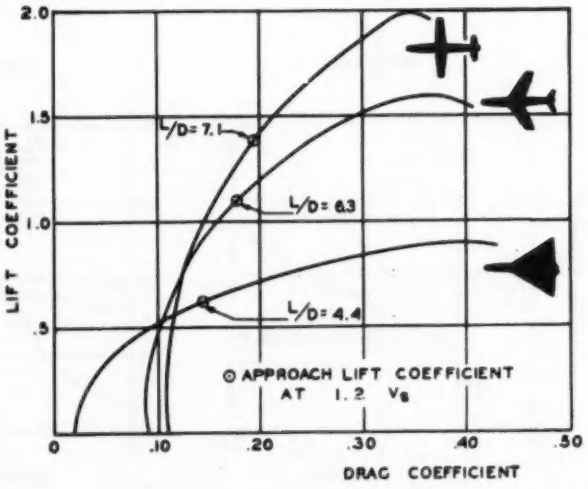


Fig. 17—Comparison of airplane polars

Preventive Maintenance

an elixir that works



Anthony D. Lucian, Thompson Products, Inc.

Based on secretary's report of Panel on Preventive Maintenance of Plant Equipment held as part of the Production Forum at the SAE National Production Meeting, Cleveland, March 25, 1953. Panel Leader was W. J. Collier, Thompson Products, Inc.

Question: What is the best way to begin a preventive maintenance program?

Answer: Start with the worst department and show an improvement to management. Move gradually.

Question: How should downtime be scheduled?

Answer: The schedule and production departments should get together on this. An attempt should be made to do repair work on weekends when machines aren't being used.

Question: Where does preventive maintenance stop and repair begin?

Answer: When regular inspections indicate the need for repair, the entire operation may be rightly termed preventive maintenance. When repairs must be made due to breakdowns, this is no longer preventive maintenance.

Question: Are vacation shutdowns used for preventive maintenance work?

Answer: Yes. With proper planning, a vast

amount of preventive maintenance can be accomplished during these periods.

Question: How do you manage to get detail drawings from machine-tool manufacturers?

Answer: We insist on complete drawings when ordering parts.

Question: How much stockpiling of parts is necessary?

Answer: A one-to-two year supply of stock parts may be kept on hand. It's a good idea to duplicate machines, thus making possible the stocking of just one part for several machines.

Question: Is machinery tagged or are office records kept? If the latter, are files or plant layouts used?

Answer: Records are kept in office files.

Question: Would 300 machines warrant installation of an IBM machine?

Answer: Yes, if it is integrated to all jobs, such as property accounting, inspection, preventive maintenance, machine location, and so forth.

Question: How do preventive maintenance hours compare with maintenance hours?

Answer: Twenty-eight percent of our maintenance payroll is preventive maintenance. We are striving for a 70% preventive maintenance figure.

Question: Do you have area maintenance, craft maintenance, and so forth . . . or is all maintenance under one head?

Answer: We have a "hot" crew on the floor under one general foreman.

Question: How is the age of a machine taken into account on a preventive maintenance program?

Answer: A chart is kept on each machine. A straight line indicates costs are satisfactory if the slope is small enough. Parabolic curves are studied for a minimum. Since older machines require higher maintenance costs to hold close tolerances, they are pulled off finishing operations and moved to roughing operations.

(The report on which this article is based is available in full in multilithographed form together with reports of the seven other panel sessions held at the 1953 SAE National Production Forum. This publication, SP-301, can be obtained from SAE Special Publications Department. Price: $1.50 to members; $3 to nonmembers.)

Quick-with-answers to queries on PM was this sextet of production experts:

W. J. Collier, Panel Leader
Plant Engineer
Thompson Products, Inc.

Anthony D. Lucian, Panel Secretary
Industrial Engineer
Thompson Products, Inc.

I. N. Tull
Superintendent, Electrical Dept.
Republic Steel Corp.

S. H. Janeski
Master Mechanic
Ladish Co.

Jim Solomon
Chief Engineer
National Machinery Co.

Leo Milan
Chief Plant Engineer
Douglas Aircraft Co., Inc.
Tulsa Plant

New axle test lab simulates for first time infinite number of road and operating conditions.

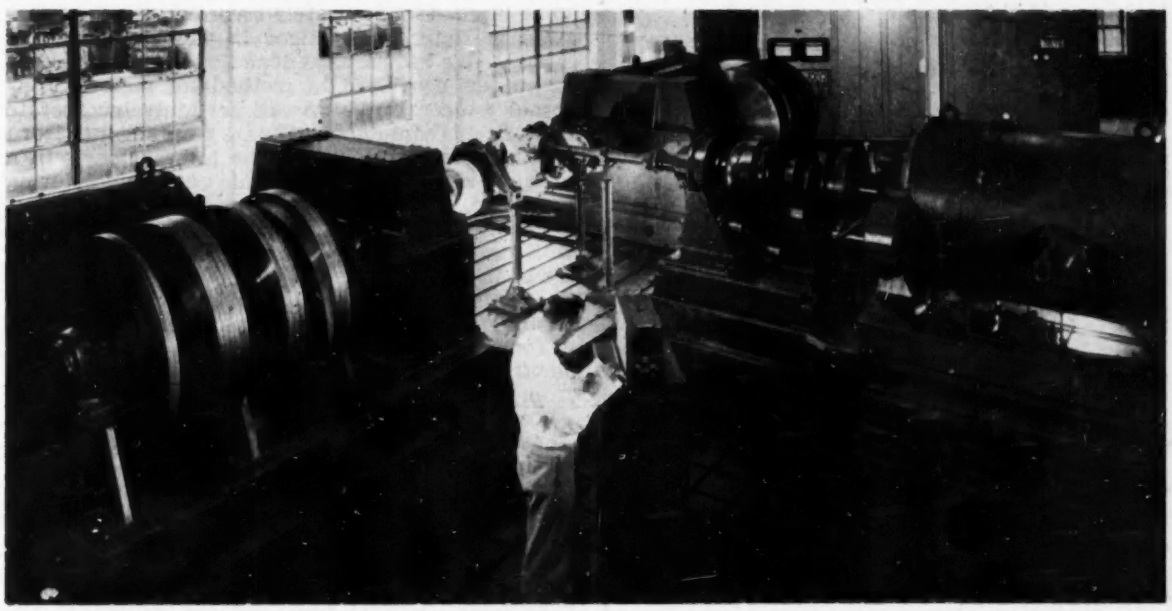


Fig. 1—Timken-Detroit Axle Co.'s new Alden Indoor Proving Ground was named in memory of the late Col. H. W. Alden, a past-president of SAE. The equipment, built and designed by General Electric to T-DA specifications, is shown here. The test stand is in the foreground, with one output dynamometer on the left and the input dynamometer on the right

Proving Ground Moves Indoors

L. W. Fischer
Vice President,
The Timken-Detroit Axle Co.

R. W. Roush
Chief Materials Engineer,
The Timken-Detroit Axle Co.

E. B. Stavely Jr.
Application Engineer,
General Electric Co.

Excerpts from paper "How a Proving Ground Was Moved Indoors" presented at SAE Annual Meeting, Detroit, Jan. 12, 1953.

THE Alden Indoor Proving Ground, shown in Fig. 1, has the most modern dynamometer equipment for testing driving axles today. It can develop the kind of information from laboratory testing previously available only from outdoor road testing. This should be a big help in designing better-performing, longer-lasting axles.

The two big things that this equipment makes possible in laboratory testing of axles are:

1. Reproducing in the laboratory the torques and speeds actually encountered on the road, with the ability to repeat these tests accurately time after time.
2. Shock loading tests.

For many years engineers have searched for a method of programming a test such that a typical run in all sorts of traffic and road conditions could be simulated repeatedly in the laboratory. An earlier method used cams and small switches; but the cams had to be changed to change the test conditions. Also there was a practical limit to the number of cams, and, therefore, to the number of speed steps.

The need was great for a method of programming that would give stepless control of the dynamometer. The automatic cycling system incorporated in the new Timken-Detroit Axle laboratory makes this possible.

Shock loading had never been developed to the point where an axle could be shock loaded in the

Conditions Simulated

The maximum conditions to be simulated by the equipment, as specified by Timken-Detroit Axle engineers to General Electric, are:

1. **An engine producing 710 lb-ft of torque at 1600 rpm and having an inertia of 48 lb-ft².**
2. **Transmission ratios varying from 1/1 to 6.5/1.**
3. **Rear axle ratios varying from 4.5/1 to 9.23/1.**
4. **A vehicle weighing 80,000 lb and operating at 60 mph.**
5. **Rear wheel diameter of 46 in.**

laboratory to the extent that it might be in service. Flywheels were not big enough to simulate the inertia of the largest trucks. There were no reliable means of suddenly applying such terrific loads. The new laboratory equipment can do this.

The type of data now attainable should throw new light on axle performance and yield real design improvements as time goes on.

For example, in a percentage of tests on the conventional dynamometer, all of the information needed to predict service performance is not always forthcoming. That's due to power and speed limitations.

Now, since we can duplicate, with this new dynamometer, the actual service of any vehicle traveling over any route, there is no reason why we cannot duplicate service results.

After testing axles on conventional dynamometers at high loads and low speeds (approximately 5 mph) and something fails, they are disassembled, and all dimensions and adjustments might have been changed while the axle was running.

With the instrumentation which has been added to the new dynamometer equipment, we can now measure any internal deflections, or movement that may occur in the vital internal parts of a driving axle, under all conditions of load, speed, and in both directions of rotation.

All of these mechanical movements are registered electrically by means of differential variable transformers and are indicated by the light pattern on the calibrated screen of a cathode ray oscillograph or oscilloscope.

Another important consideration in an axle is the proper flow distribution and the internal operating temperatures of the gear lubricant. There is much to be learned by accurately recording the temperatures at different locations in the lubricant flow stream. We have always done this; but as improvements are developed in methods of recording internal temperatures, we will certainly incorporate them in this equipment. We are most eager to learn about rising temperatures, the internal parts in a driving axle, their causes, effects and control during operation.

The measurement of stresses of the different parts while running in service, is becoming more common. It will only be a question of time until we will be able to not only measure, but record stresses, on all important parts, at all loads during operation.

The measurement of vibration and sound has possibilities if they can be localized at one spot free from interference.

Knowledge gained from such projects can be used in a great many ways. It can be incorporated into original designs or into existing designs in such a way that greatly improved performance will result.

It might be found that parts can be made smaller and lighter and still carry the same load. Or it might be possible to downgrade material, which is the all-important thing in view of material shortages today. Carbon steels may be substituted for the highly restricted alloy steels. If we are required to win another war, this will be an important contribution.

The Test Equipment

The test stand, Fig. 1, consists of an input dynamometer, an input clutch and flywheel, and two output dynamometers, each having a speed increasing gear, an absorption generator and a flywheel. The equipment is shown schematically in Fig. 2. During normal operation, the input dynamometer, replacing the engine, acts as a motor with its power absorbed by the two absorption generators. Of course, for simulating downhill operation or deceleration, the direction of power flow is reversed. Not shown here are the motor-generator sets, the amplidynes, or the control equipment.

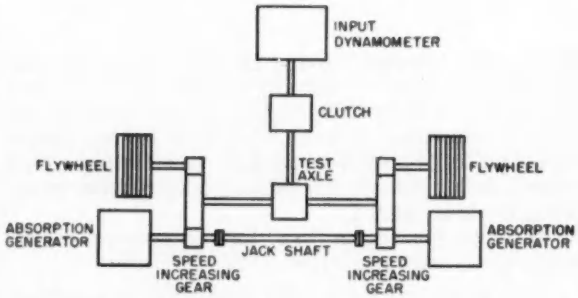


Fig. 2—Schematic arrangement of the test stand. The jack shaft is not used during normal operation

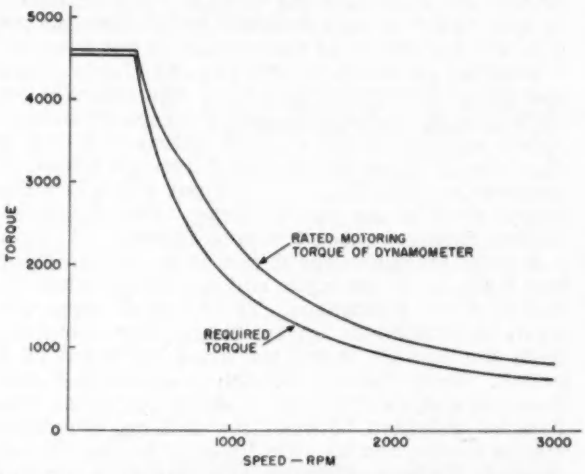


Fig. 3—Characteristics of the input dynamometer, showing how torque of the input dynamometer rated 350/450-450 hp, 400/750-3000 rpm compares with the required torque

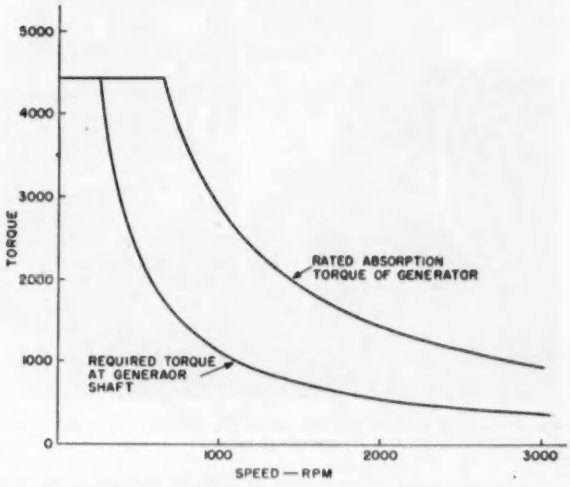


Fig. 4—Characteristics of the absorption generator, showing how torque of the generator rated 550 hp, 650-3000 rpm compares with required torque, which has been reduced by 5.12/1 gear ratio

An input dynamometer rated 350/450-450 hp motoring, 400/750-3000 rpm, 195/250-250 volts was selected by the design engineers as the best machine to accomplish the desired results. Fig. 3 shows how the torque characteristic of the dynamometer compares with the torque required by the Timken-Detroit specifications. While the rating of 450 hp from 750 to 3000 rpm is greater than required, it was dictated by the desirability to limit the speed range by field control to 4/1 or 5/1. This limitation results in a direct current motor having better commutating ability than one with greater field range, particularly when a 3000 rpm maximum speed is required.

In order that input torque can be measured accurately, the dynamometer is cradled in motor-rotated trunnion bearings. The rotated bearing requires less maintenance and results in sustained accuracy. The Baldwin torque indicating equipment is of the resistance strain gage type acting on the torque arm of the dynamometer. Four strain gage elements are the arms of a balanced Wheatsone bridge. Another bridge in the torque indicator is then balanced by a motor driven contact on a slidewire. A dial indicates the position of the contact and hence shows dynamometer torque.

Between the input dynamometer and the axle is a combination flywheel, reduction gear and clutch. This assembly manufactured by the Laboratory Equipment Corp., is a very important part of the dynamometer equipment. The operation of the clutch is discussed later in this article under shock loading.

As in most rear axle testing, a speed increasing gear is used so that the absorption dynamometer may be operated at practical speeds. Otherwise it would become very large and expensive if it had a top speed of only 570 rpm. Since the gear ratio could be whatever would make the best dynamometer design, approximately 5/1 was selected by the engineers. The generator was then rated 550 hp, 650-3000 rpm, 250 volts. This rating is based on the torque requirement of 22,700 lb-ft at 50 rpm, this being the requirement at the low speed shaft of the speed increasing gear.

Fig. 4 shows the comparison of the required torque and the rated torque of the absorption generator at generator shaft speed. The absorption generators are of the same construction as the input machine, except that they are not cradled but are used purely to absorb power. Since other dynamometers are available in this laboratory for measuring axle efficiency, an accurate measurement of output torque is not required of this equipment. The input torque is measured, and its value along with the known axle efficiency will give a sufficiently accurate measurement of output torque.

So long as it is necessary to use a gear to increase the speed of the dynamometer, it is logical to increase the speed of the output flywheel also. The overall length of the output unit was held to a minimum by mounting the flywheel and dynamometer side by side, each connected to a separate pinion on the gear unit. A diameter of 48 in. was selected for the flywheel and a 3/1 ratio for the gear. Incremental disks on the flywheel represent 2500 lb and 3500 lb of truck weight when simulating a truck with 46-in. wheels.

The speed increasing gears are rated 215 hp, 600/1786/3072 rpm with a maximum torque of 22,-700 lb-ft at the low speed shaft. They were designed for shock loading at twice rated torque. The gear is of the double helical type with forced lubrication from a separate motor driven pump. An oil-to-water heat exchanger is used for cooling the oil. The dynamometer pinion (5.12/1 ratio) has two

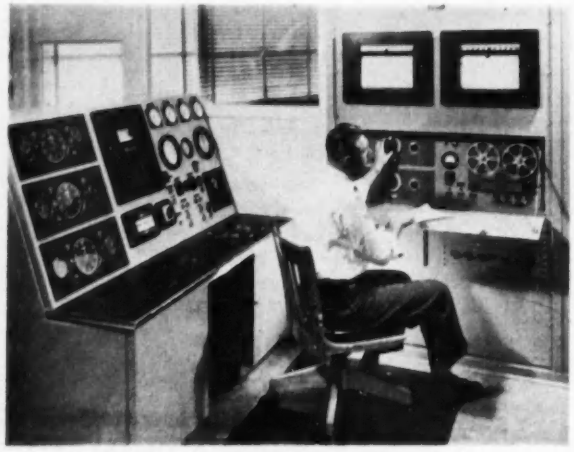


Fig. 5—Control section showing operator's console at left and cycling control at right

shaft extensions so that a jack shaft can be connected between the two output units to lock the differential if desired.

The automatic cycling equipment is perhaps the most novel feature of the entire equipment, but the intricate details of the electronic equipment are beyond the scope of this article. A front view of the cycling control equipment is shown in Fig. 5.

The two instruments at the top are Brown strip chart recorders which indicate and record speed of the input dynamometer and torque of the absorption machines. The tape recorder is at the right and is surrounded by the required oscillators, amplifier, discriminator, reversing unit and power supply.

The magnetic tape recorder has two separate recording channels located side by side on the magnetic tape. One track is contacted while the tape moves from right to left and the other track is contacted when the tape is moving from left to right. Automatic change of direction at either end of travel is provided so that a test can be repeated again and again without shutting down the equipment. The maximum duration of a single operating sequence is two hours.

Both speed and torque as well as a signal for reversing the direction of the tape are carried on only one channel of the magnetic tape. This is accomplished by superimposing various frequencies on one channel.

During recording, these signal frequencies are obtained from the oscillators and are 300 to 900 cycles per second for torque, 3000 to 6000 cps for speed, and 1500 cps for reversing. When the original test is being duplicated during playback, the discriminator separates the frequencies by means of filters and converts them back into signals of speed and torque.

Shock Loading Tests

The heart of the equipment when used for shock loading is the clutch in the input to the axle. It is shown in schematic form in Fig. 6. The splined sleeves at each end of the unit and positioned by levers, are shown in the disengaged position. During normal testing, the sleeve at the input end bridges the splines on the input and output shafts so that power is transmitted straight through the unit without the use of the clutches or the flywheel.

Mounted on hollow shafts are the clutch plates and the planets of the gear unit. The clutches are spring-closed and are opened by means of air cylinders controlled by solenoid valves. During a shock loading test, the splined sleeves are moved to connect the input shaft to the input clutch and the output shaft to the planet carrier. The clutch operation during a shock test is as follows:

All dynamometers are at rest at the beginning of the cycle, with the input clutch engaged and the output clutch disengaged. The operator brings the input dynamometer up to speed. The operator, from the console, starts the cycle by means of a switch. First, the input clutch is disengaged, and then the output clutch is suddenly engaged. The flywheel mounted between the clutches simulates engine inertia and its stored energy is transmitted through the output clutch and planetary gear to the axle and hence to the output flywheels.

The magnitude of the shock loading depends upon the speed of engaging the clutch. When the clutch becomes completely engaged, the entire assembly is operating at low speed and that cycle is complete.

Naturally, much of the stored energy of the input flywheel is dissipated in the clutch, but this fact is not an important consideration. It is the rate of application of torque to the axles that is of utmost importance in producing the desired stress on the axle for this type of test. Under shock loading conditions, the testing equipment itself is capable of withstanding up to twice the maximum normal torque.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

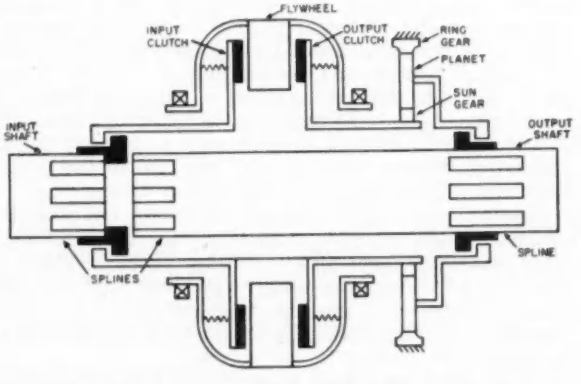
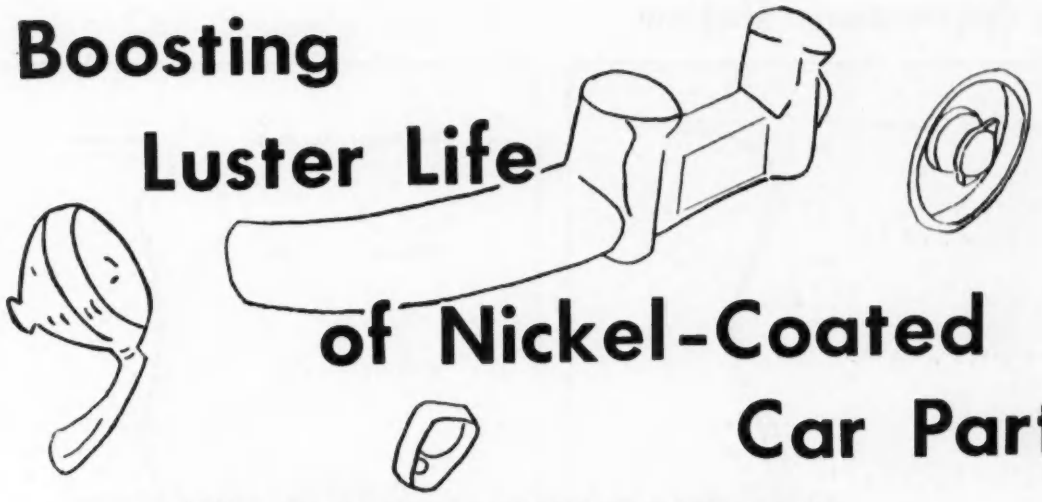


Fig. 6—Schematic of input clutch and flywheel unit. Splined sleeves are shown solid

Boosting Luster Life of Nickel-Coated Car Parts

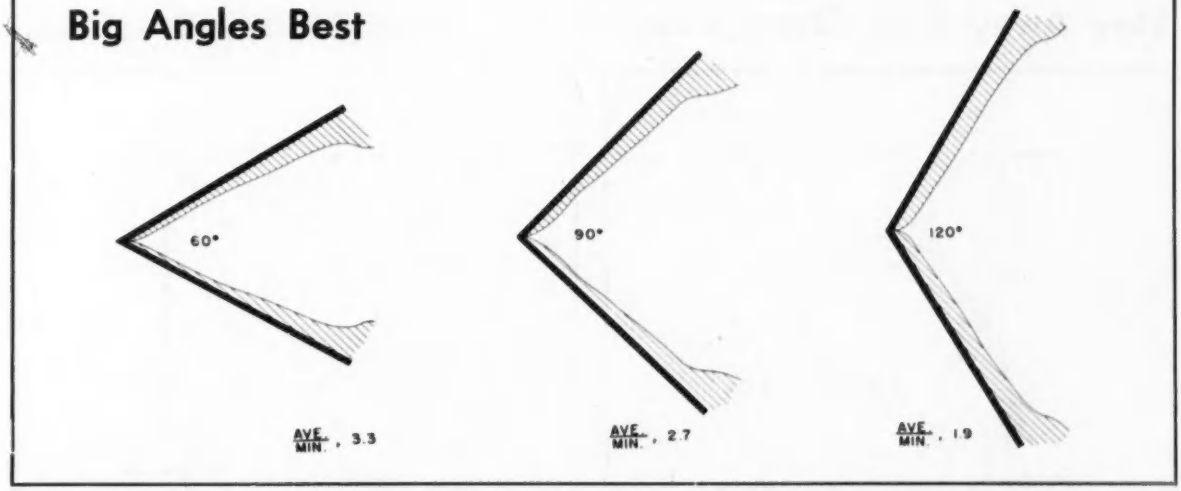


. . . Making ornamental car parts simple in design is the key to getting the most mileage out of nickel available today. That's because nickel can be distributed more uniformly on brightwork that is free of sharp depressions. What's more, scratches in the base metal—which determine how thick the nickel plate must be—can be buffed out better and easier with smooth forms.

D. M. Bigge, Chrysler Corp.

Based on paper "Chromium-Plated Automobile Parts—Their Materials, Designs, and Finishes" presented at SAE National Passenger-Car, Body, and Materials Meeting, Detroit, March 3, 1953. Complete paper in multilithographed form may be obtained from SAE Special Publications Department at 25¢ a copy to members, 50¢ to nonmembers.

Big Angles Best



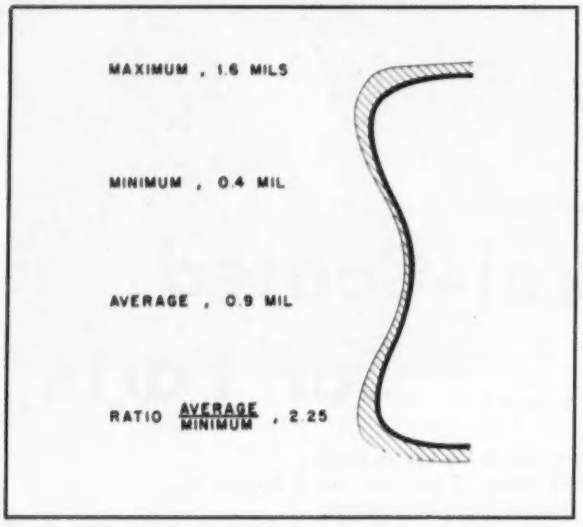
From the standpoint of getting a uniform coating of nickel, the bigger the angle between two mating surfaces of a part the better.

For example, when two surfaces meet at 60 deg, the ratio between average plate thickness and minimum plate thickness is 3.3. (Under ideal conditions, this ratio would be unity.) However, as the angle grows, the ratio at 90 deg becomes 2.7 and at 120 deg it falls to 1.9. With a flat surface or 180 deg angle, the ratio would, of course, be unity.

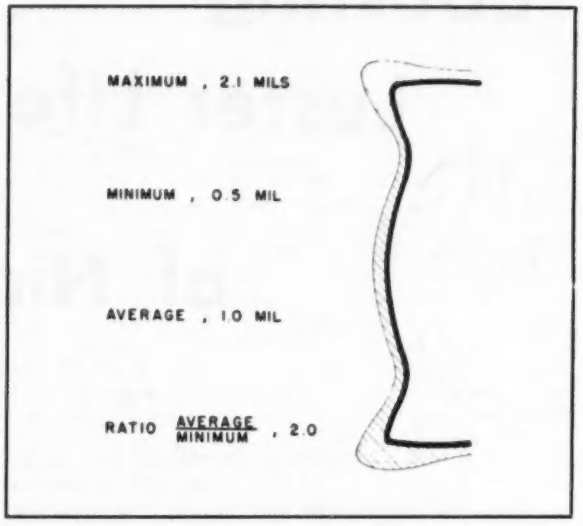
It is interesting to note that the thinnest nickel area is the junction point of the two surfaces. Naturally, this would be the area in which rusting or corrosion would be most likely to occur first.

Please turn page

Keep Depressions Shallow

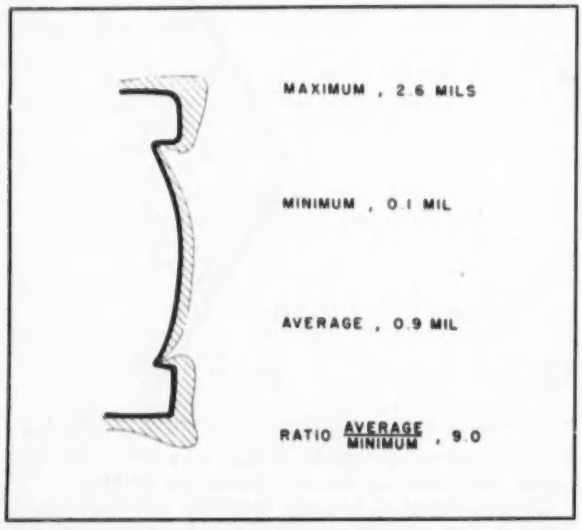


BAD—Parts with a deep depressed area do not lend themselves to uniform distribution of nickel plating. As shown above, the ratio of average to minimum nickel plate thickness for such a part is 2.25.

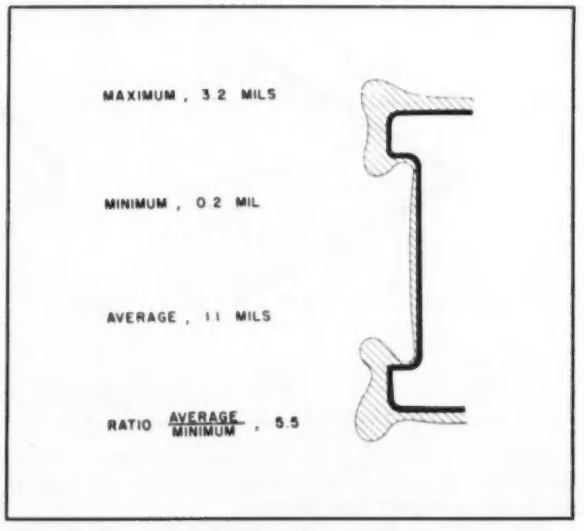


BETTER—Improvement that can be had in nickel distribution by using two shallow recesses instead of one deep one in the face of the part shown on the left. Note that the ratio drops from 2.25 to 2.0.

Stay Away from Sharp Corners

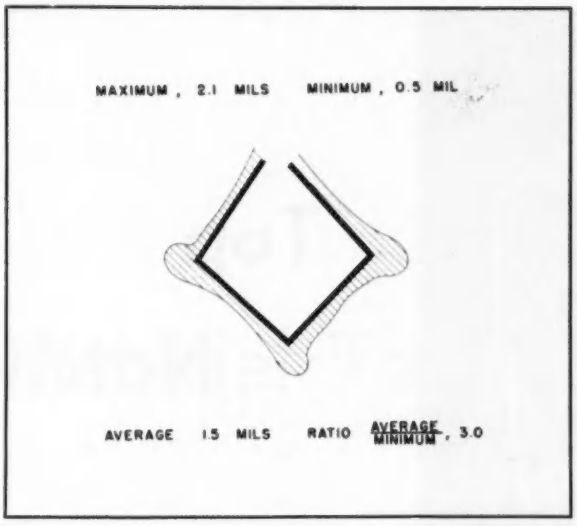


BAD—Sharp corners in recessed sections are bad. This is graphically illustrated by the above part. Note that the ratio of average to minimum plate thickness is a whopping-big 9.0.

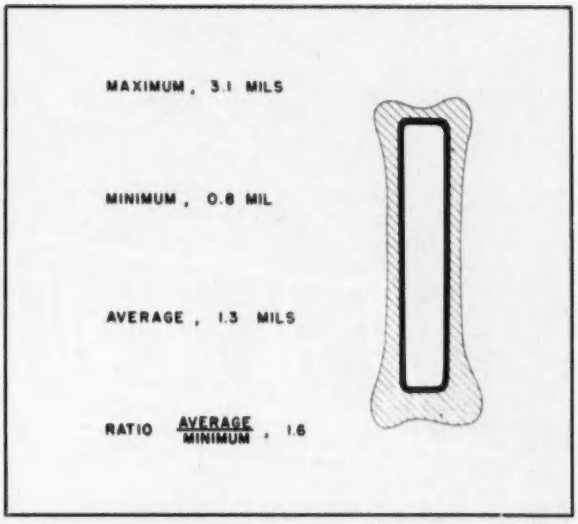


BETTER—The nickel coating characteristics of the part on the left can be improved almost 100% by rounding off the recessed corners . . . and by flattening out the central recessed face.

Stretch Out Squares

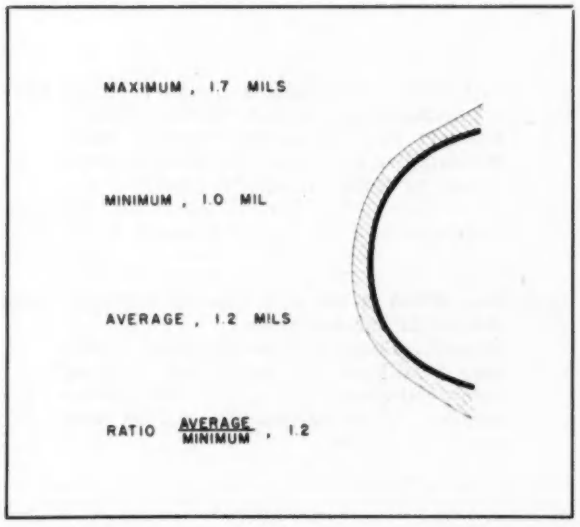


BAD—With square forms, nickel will pile up at each corner. This is undesirable for two reasons: (1) A buffing operation becomes necessary, (2) Nickel thus buffed off is a complete loss.

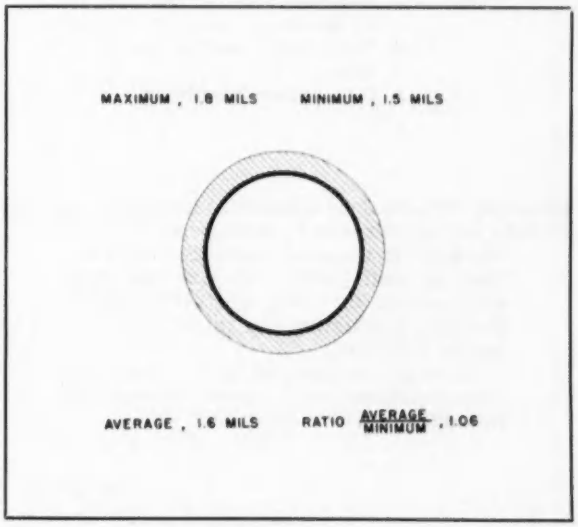


BETTER—Nickel distribution is much better on closed rectangular-shaped parts. Nickel buildup still occurs at corners, it is true, but not to the extent that it does with the part shown at the left.

Aim for Circular Shapes

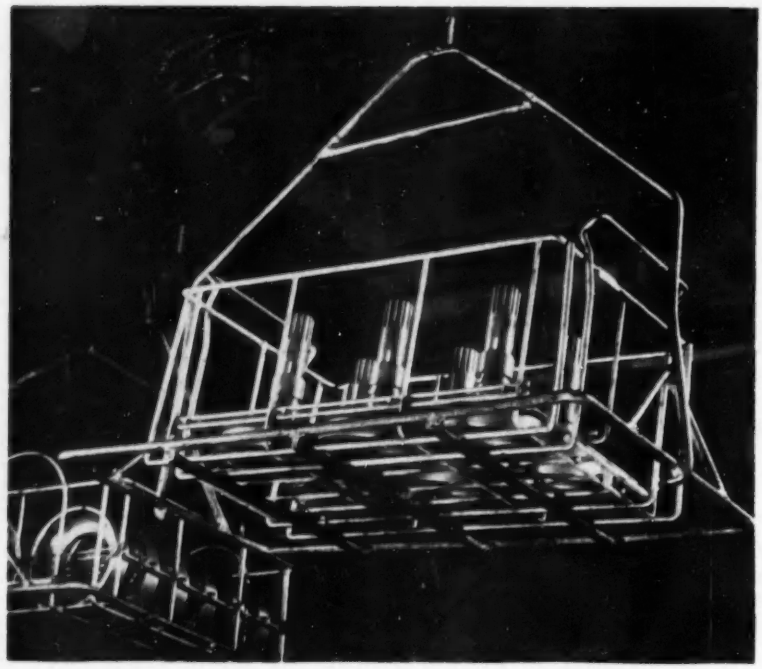


GOOD—Parts with fairly uniform curved faces lend themselves very well to uniform nickel plating. The ratio of average to minimum nickel plate thickness here is a good 1.2.



BEST—Circular-shaped parts are real nickel misers. With them, it's possible to obtain average to minimum thickness coating ratios that approach the theoretical minimum value of unity.

CONVEYOR-DRAWN open-wire baskets — one of today's



Top Notch

Question: What are the five most important material handling facilities in industry today?

Answer: 1. Conveyors—chain, cable or belt
2. Fork trucks
3. Pallets—wood, metal, paper or mesh
4. Tote pans—solid, mesh or wire
5. Collapsible containers.

Question: Where does a material handling engineer fit into an organization? Who does he answer to?

Answer: A material handling engineer holds a staff position in the industrial engineering division, master mechanic division, production control or under the works manager.

In some companies their work and appropriations are passed on by top management.

Question: What can properly applied material handling engineering accomplish?

Answer: Properly applied material handling engineering can make a plant more efficient, thus cutting production costs. Among the things that it can accomplish are standardization of material handling methods and equipment, reduction in stocking and storage space, and decreased stock deterioration.

Question: Should standard or made-to-order containers, packages and cartons be purchased?

Answer: It's best to get together with the supplier and design a reusable container to company specifications.

Question: What is the best type of material handling container for foundries?

Answer: Some companies have saved over a million rehandlings per year by using collapsible, returnable metal containers. These containers can be used about 300 times.

Question: What are the advantages of pallet racking?

Answer: Pallet racking is one way to control stock rotation.

Material Toters

S. D. Sanders, Leece-Neville Co.

Secretary's report of Panel on Material Handling held as part of the Production Forum at the SAE National Production Meeting, Cleveland, March 25, 1953. Panel Leader was H. O. Horning, Chrysler Corp.

Question: Are the same pallets able to handle various size loads?

Answer: Yes. They can be adjusted to various widths and heights.

Question: How fast can investment in pallet racks be amortized?

Answer: Within one year.

Question: What is the best way to control rotation and handle stock shortages with small parts such as screws?

Answer: Use containers that lend themselves to first in-first out rotation and handling . . . and "tickler" tab cards on sealed containers. The latter should be set to proper lead times.

(The report on which this article is based is available in full in multilithographed form together with reports of the seven other panel sessions of the Production Forum held at the 1953 SAE National Production Meeting. This publication, SP-301, can be obtained from SAE Special Publications Department. Price: $1.50 to members; $3 to nonmembers.)

Handling the bevy of material-handling questions was old stuff to this material-handling-conscious group:

H. O. Horning, Panel Leader
Material Handling and Packaging Engineer
Chrysler Corp.

S. D. Sanders, Panel Secretary
Administrative Consultant
Leece-Neville Co.

Harry Diefendorf
Consultant and
Material Handling and Package Engineer

D. W. Kelsey
Material Handling and Packaging Engineer
A. O. Smith Corp.

A. Hancox
Plant Layout Engineer
Cleveland Graphite and Bronze Co.

A Car Takes Four Lubes

IT takes four major types of lubricants to protect automotive parts against mechanical and chemical wear—engine oils, transmission oils, rear-axle oils, and greases. But what does it take in these lubricants to permit them to do their respective wear-prevention jobs?

Here's how this question can be answered as of today. The prime requisites for each of these basic types of lubricant are:

1. For engine oils—proper oil viscosity and viscosity index.

2. For transmission or gear lubes—pressure-viscosity properties capable of preventing surface failure. Automatic transmission fluids must permit good friction coefficients between steel and friction-band materials.

3. For hypoid gear (rear axle) lubes—mineral oils must be fortified with additives which will react chemically with the gear surfaces to form solid film lubricants.

4. For greases—the lubricant must be able to overcome fretting of automotive mechanisms.

1. Engine Oils

The best engine lubricant in the world can't prevent wear of piston rings and cylinder liners unless it is present on these parts in sufficient quantity the instant the pistons begin to move up and down. Therefore, in order that adequate lubrication may be established promptly, crankcase oil should have as low a viscosity as possible under the prevailing operating conditions. The limiting viscosity is dictated to a large extent by oil-consumption characteristics, but ring-belt temperatures and bearing design are also important. It follows that the lubricant should change as little as possible in viscosity with temperature. In other words, it should have a high viscosity index.

The question of how low in viscosity an oil can be before scuffing and excessive engine wear are encountered has been debated for a great many years, and the debate is still going on. The only satisfactory way of answering this question is to "ask" the engine. The fact remains, however, that the trend in crankcase oils over the years has been to lower viscosity levels, and this trend is still continuing. Many automotive engines are being lubricated satisfactorily year round with oils in the SAE 5W category. Furthermore, successful operation is being obtained in both laboratory and field tests with oils of even lower viscosity than those permitted under the 5W classification.

Data obtained by Esso Laboratories show that at least in some engines and under certain operating conditions low viscosity oils give substantially less wear than those of higher viscosity. The results of tests made on a group of four uncompounded mineral oils varying in viscosity from 36 to 59 SUS at 210 F, but all made from the same general crude source and all refined in the same manner, are presented in Fig. 1. In these tests, piston-ring wear with the oil having a viscosity of 36 seconds was less than two-thirds that obtained with the oil of 59 seconds viscosity.

During recent years considerable improvement

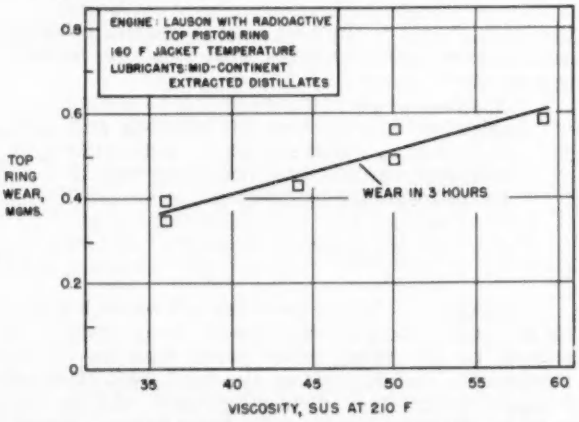


Fig. 1—Low viscosity engine oils give substantially less wear than lubes of higher viscosity under certain conditions

That Have What It Takes

J. F. Kunc, Jr. and J. P. Hamer,
Esso Laboratories, Standard Oil Development Co.

Excerpts from paper, "Lubricants—The Surface Savers," presented at SAE Annual Meeting, Detroit, Jan. 13, 1953. Paper will be published in full in 1953 SAE Transactions.

has been made in the wear characteristics of engine oils. This progress has been brought about almost entirely by the use of additives—not by changing refining techniques.

Detergent additives have not only been eminently successful in reducing engine deposits, but they've also helped decrease piston-ring and cylinder-liner wear. Oxidation inhibitors, by improving resistance of oils to oxidation at high temperatures, have helped out, too.

The degree to which detergent additives can reduce piston-ring wear in diesel engines is illustrated in Fig. 2. Note that the Series II type oil, made by adding roughly 16% of additive to the base oil, showed only about 15% as much wear as the base oil. Correspondingly less reduction in wear was obtained with the lower additive concentrations required to make 2-104B and Supplement I oils.

The magnitude of wear reduction obtained in gasoline engine crankcase oils through use of detergent additives will however vary considerably, depending on the type of service to which the oils are subjected. This, in turn, is related to the kind of engines being used, the quality of the fuel used, and a host of other factors.

A rather wide variety of materials which might be termed "oiliness" agents are being used in some crankcase oils. The term "oiliness" agent is used rather loosely, but it usually is applied to compounds which are capable of reducing the coefficient of friction or increasing the load-carrying ability of crankcase oils.

There is little doubt that under conditions of boundary lubrication beneficial effects can be demonstrated for certain oiliness agents. However, an increasing amount of evidence is being accumulated which shows that a reduction in the coefficient of friction of an oil or an improvement in its load-carrying ability does not necessarily lead to a reduction in engine wear. As a matter of fact, some oiliness agents have proved to be harmful rather than beneficial when used in engines because of undesirable corrosive effects.

A considerable amount of research work is being done, both within and outside the petroleum industry, on the development of synthetic oils of the ether and ester type which might find application as crankcase lubricants. At least one wholly synthetic oil is now being marketed for this purpose.

It is too early to predict where this research will ultimately lead, but up to the present time there is no evidence to show that synthetics offer any advantages over petroleum base oils from the standpoint of engine wear. It is quite probable, however, that oils produced synthetically and designed to have specific performance properties may find increasing application in the crankcase oil field during the next decade or so. One of the very im-

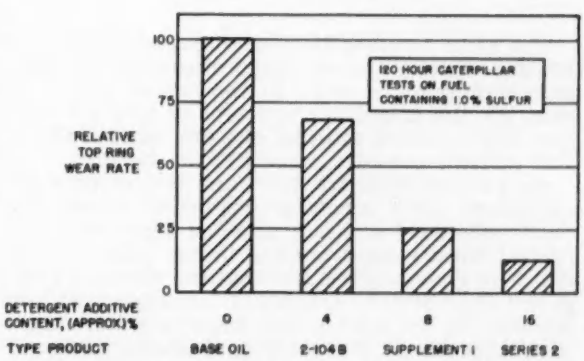


Fig. 2—Detergent additives reduce piston-ring wear in diesel engines

portant considerations in this field will reside in the economics of making synthetic oils.

With more compact automotive engines in the works for the future, temperatures and pressures on engine lubricants are bound to be greater. Needed improvements in crankcase oils will come from chemical additives or synthetic base oils rather than through further refinement of mineral oil base stocks.

2. Transmission Fluids

In transmissions, conventional designs impose light loads on gears. So conventional mineral oils do an adequate lubricating job. Proper lube viscosity under high pressures will prevent wear, scoring, galling, or other surface failure of gear teeth.

Automatic transmissions have greatly different requirements than those of conventional manual-shift units. Operating temperatures are considerably higher than in conventional transmissions, and fluids are subjected to very high rates of shear. A low viscosity is desirable to minimize viscous drag of the oil, obtain maximum efficiency, and permit easy starts at low temperatures. At the same time, a normal viscosity level is required at operating temperatures for satisfactory lubrication of associated gears and bearings. Fluids of high viscosity index are therefore desirable for this service. Oxidation inhibition and detergency are required to provide long oil life and to prevent the deposition of sludge deposits in vital portions of the system.

The critical problem in these units is generally the lubrication of friction-band material rubbing on steel. Satisfactory lubrication of the friction-band material is important to prolong its life and to obtain sufficient smoothness for the various gear shifts of automatic transmissions. It represents a system which must have exact friction characteristics.

Presently available types of transmission fluids appear to be giving generally satisfactory performance. No marked changes are expected in the near future.

3. Rear-Axle Lubes

The same considerations of viscosity applying to oils for manual transmissions also apply to rear-axle or differential oils. In the hypoid gear unit, however, the magnitude and type of load are such that conventional mineral oils are unsatisfactory, and extreme-pressure properties are required.

An extreme-pressure lubricant is one that incorporates some chemical compound which can more effectively separate meshing gear teeth and protect them against surface failure than mineral oil. This generally requires that the chemical compound or additive be capable of forming a solid film lubricant on the steel surface which is removed only with difficulty by the rubbing or sliding action of the gears.

Phosphorus, sulfur, chlorine, and lead compounds, individually or in combination, are additives used in extreme-pressure gear lubricants.

Main considerations in selecting the type of additive to be used in an extreme-pressure lubricant are: (1) ability to maintain adequate lubrication, (2) effect on the oxidation stability of the base oil, and (3) ability to resist the action of water which may enter the mechanism.

Effective gear oils are widely available for present equipment. Future automotive rear axles are expected to continue to use as small gears as possible, with consequent higher unit loading. This trend will probably be accompanied by the development of even more effective extreme-pressure lubricants.

4. Greases

Greases are used widely in automotive applications to prevent wear in those mechanisms to which an adequate volume of oil cannot be supplied.

Most greases consist of a mineral oil thickened with a soap. For general chassis lubrication, a calcium (lime) soap grease is employed satisfactorily. In such applications, the primary requirement is that the grease not run out of the mechanism, so that adequate lubrication and an effective dirt seal are maintained. Certain components—such as wheel bearings—need a grease of better structure stability. Sodium soap greases are widely employed.

In recent years, multipurpose greases have appeared on the market. Use of multipurpose greases eliminates the need for handling more than one grease in service stations and minimizes the possibility of misapplication. Only trouble here is that these greases cost more. The service-station operator doesn't want to pay the extra price, particularly when most of his business requires only lower priced grease. It is expected however that interest in the multipurpose types of grease will continue.

Fretting of wheel bearings occasionally gives bearing surface failure. It has been found that use of a soft grease with a high bleeding rate is a very effective means for minimizing fretting.

The National Advisory Committee for Aeronautics has found that molybdenum disulfide is an effective material for preventing fretting under some circumstances. In some cases molybdenum disulfide does not completely eliminate fretting. Furthermore, control of fretting with molybdenum disulfide is fairly expensive because of high cost of the basic material and difficulty of correctly applying it.

No marked changes are visualized in the lubrication requirements of grease-lubricated automotive mechanisms or in present types of greases. Although greases using synthetic oil bases are used under extreme temperature conditions, such as in aircraft, it is doubtful that products of this type will be widely used, especially in view of their high cost.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)



This will be brought about by . . .

The Coming Revolution in Flight Propulsion

D. G. Samaras, Flight Research Laboratory, Wright Air Development Center

Based on paper "The Dawn of Aviation's New Era" presented at SAE Annual Meeting, Detroit, Jan. 14, 1953.

SPACE travel probably will force a complete break with thermal propulsion methods. Powerplants beyond the wildest imagination of science fiction writers may be propelling interplanetary and intergalactic space craft in the future.

Instead of propulsive thrust from heat derived from chemical, and nuclear energy, we'll get propulsive thrust from acceleration of electrical and light particles. That will eliminate the high energy losses from thermal propulsion systems.

Classical thermodynamics states that the Carnot efficiency is the highest to be expected from any thermal cycle operating between the two given temperature levels. Again, the efficiency of the Carnot cycle depends upon the ratio of the absolute temperatures between which it operates; consequently, an increase in attainable cycle efficiency can come only from an increase of the maximum cycle tem-

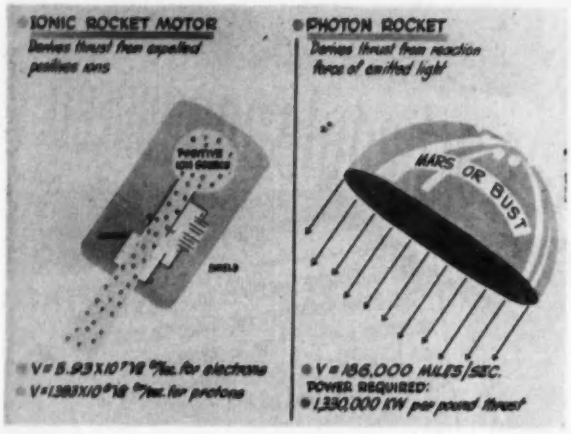


Fig. 1—The Ionic Rocket and Photon Rocket, futuristic examples of non-thermal propulsion systems, suggest mental fare for research in jet propulsion

perature or from a decrease in the minimum cycle temperature, the latter being rather improbable. Again, a thermal propulsion system requires some sort of cooling system with its attendant problems. From these considerations it is seen that the thermal propulsion system is handicapped by definite and serious limitations. It will doubtless remain our primary source of propulsion thrust for quite some time to come, but in the interest of economy it will be superseded eventually by a non-thermal system.

Electrical Thrust

As a first, perhaps futuristic, example of a non-thermal propulsion system we may consider the "Ionic Rocket". This jet propulsion system can convert electrical potential directly into accelerated particles, that is, by the electrostatic acceleration of ions (Fig. 1). Such a system would eliminate the thermal cycle with its attendant low thermodynamic efficiency, but it will create a large number of other complicated problems. The particle velocities attainable are considerably higher than those obtainable by a polytropic expansion of heated gases, thus permitting very high thrusts per unit mass flow.

The efficiency of converting electrical into kinetic energy of such a system may be of the order of 90%. The problem of maximum overall efficiency would then be reduced to one of matching the vehicle velocity to the particle velocity to obtain a high propulsive efficiency.

Some of the most important problems to be solved before such a system can be put into operation are:

a. Discovery of a high intensity source of low mass ions.

b. Development of a transportable source of electric power.

The ideal solution then for an ionic rocket would be represented by a method for direct conversion of nuclear into electrical power with the simultaneous formation of ions. However, it should be remembered that the ionic rocket, although having a high mass efficiency, would not be as efficient as the ultimate system converting nuclear energy directly into propulsion (mechanical) energy, as, for example, by the direct application of nuclear forces.

Lift from Light Rays

A conception of a photon rocket, a vehicle deriving its propulsive thrust from a reaction force of light emission, is shown in Fig. 1 for the sole purpose of indicating the nature of forces available for use in propulsion. It is far removed from practical use by the limitations of present materials and power sources. However, the above mentioned systems are recommended food for thought for future research in jet propulsion.

The performance of a propulsion system installed in a flying vehicle depends upon the following factors in decreasing order of importance:

a. Fuels (propellants)

b. Materials (cooling)

c. Fluid Dynamics

d. Matching and Control

No truly significant increase in caloric value can be expected from the utilization of the so-called "exotic" chemical fuels such as boron hydrides and other metallic fuels. This is obvious from Fig. 2 which shows the specific calorific energy release obtainable by chemical combination and by nuclear fission and fusion of the elements, plotted against atomic number, and by Fig. 3 which shows the same data for the hydrides of the elements.

These two figures also show the calorific value for the association of hydrogen atoms ($H + H \rightarrow H_2$). This reaction lies in an uncharted region of fuels between chemical and nuclear fuels. These fuels are termed "boosted" or "metastable" because the chemical reactants existing in this region are in the thermodynamically unstable form of dissociated radicals, molecules with highly excited structures, or high energy particles. The region has not been sufficiently investigated to determine what fuels might lie here if the excited state could be stabilized by catalysts, electromagnetic fields, and so forth. The future may bring considerable advances in our understanding of this virgin field.

The utilization of nuclear fuels will undoubtedly present big problems in control. One solution will be a watering down of the energy content to lower, more controllable levels.

Need New Fuel Concept

If calorific value is used as the sole criterion of fuel performance assessment, it may lead to false conclusions. A more significant performance parameter is the specific impulse, defined as the pounds of thrust per pound of propellants expended per second, and sometimes erroneously expressed in seconds. The density of a fuel or propellant is also an important factor. Present day chemical fuels lie in a very narrow range of performance, a range insufficient if long-range, one-step rocket vehicles

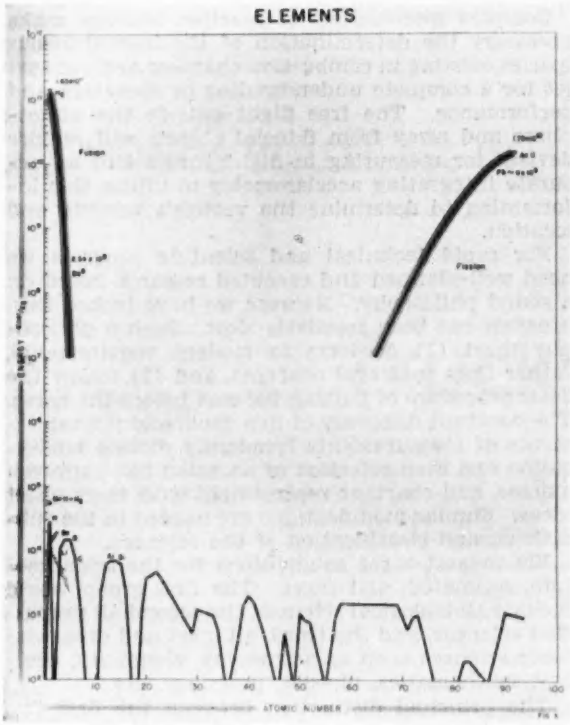


Fig. 2—The specific calorific energy release obtainable by chemical combination and by nuclear fission and fusion of the elements, plotted against atomic numbers

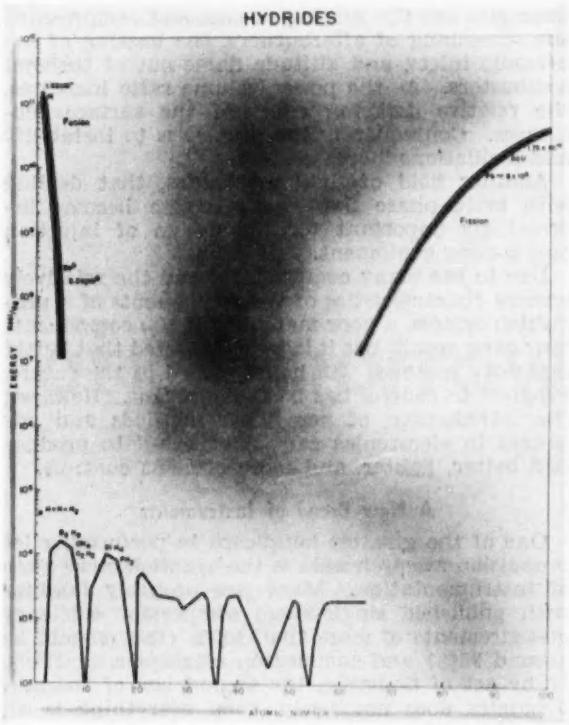


Fig. 3—Data similar to that shown in Fig. 2 applied to the hydrides of the elements

are to be used in aviation. By changing the fuel from a chemical to a metastable one, such as monatomic hydrogen, a manifold increase in the order of performance may be obtained. The main problem at the present time seems to be the stabilization of these fuels against contamination and shock for a reasonable length of time.

The energy release process is of great importance. In the case of a chemical fuel it is controlled by a large number of influences whose relative importance varies from region to region. Such influences are connected with the reaction kinetics of the process, the physical process of radiation, and the fluid-thermodynamic processes of injection, evaporation, turbulent mixing, heat propagation, and fluid oscillations. Subsonic, transonic and supersonic region energy release require different operative mechanisms, and progressively more understanding is neccessary for their successful exploitation. Surface and/or catalytic combustion is another field which has been little explored in the past.

Materials Must Beat the Heat

Materials are second in order of importance in performance of propulsion systems. It is well known that engines can operate at considerably higher temperatures when the metal surfaces are cooled. Obviously, improved heat transfer methods for cooling highly thermally stressed parts will have a tremendous influence in future development. Growing interest in ceramics and ceramets indicates their future use in components of propulsion systems.

It is obvious that the heat to be extracted through the skin per unit area decreases rapidly with increasing altitude. If materials more heat-resistant than aluminum are used, higher skin temperatures may be used and consequently, considerably smaller amounts of heat be extracted. Irradiation heating from the sun and radiation cooling are important above altitudes of 100,000 ft. The skin temperature at which irradiation heating equals the radiation cooling is nearly 260 F. Consequently, for permissible skin temperatures above 260 F, radiation has a most beneficial cooling effect which increases rapidly with increasing skin temperature.

Fluid dynamics ranks third in propulsion systems. Typical examples of such dynamics are mostly connected with turbomachinery, unsteady and especially oscillating flows, vortex flows, and others. Great advances are expected by the use of transonic and supersonic compressors. Also, considerable improvement in turbine performance may be expected by the utilization of supercritical flow turbines, both for rocket pumps and gas turbine drives.

Fluid oscillations are mostly connected with instabilities of fluid motion in individual components.

Examples are the surging of subsonic compressors, the screeching of afterburners, the buzzing of supersonic inlets, and altitude flame-out of turbojet combustors. As the power/volume ratio increases, the relative damping effect of the surfaces decreases. Consequently the proneness to instability and oscillations increases.

Another field of fluid mechanics, that dealing with multi-phase flows, promises to become increasingly important for the design of injection and cooling equipment.

Due to the many compromises and the relatively narrow characteristics of the components of a propulsion system, a poor matching of the components may early result, but it is to be expected that better matching methods will be developed in the future. Progress in control has been significant. However, the introduction of non-linear methods and advances in electronics can be expected to produce still better, lighter, and more efficient controls.

A New Breed of Instruments

One of the greatest handicaps in performing jet propulsion research work is the unsatisfactory state of instrumentation. Many are probably familiar with published single-stage compressor efficiency measurements of more than 100% (they should be around 90%) and combustion efficiencies of 111%. If, by act of Congress, the second law of thermodynamics does not apply, then everything is all right, but diligent search reveals no such legislative provision and the trouble seems to lie in the use of primitive instruments.

A principal development in the future will be perfection of old and invention of new instruments to permit accurate determination of the operating processes of thermal and non-thermal systems. This requires pressure and temperature transducers of high frequency response because of the oscillatory nature of combustion processes. No present detector can follow changes satisfactorily. Nuclear power in rockets will require new temperature transducers which will respond accurately to temperatures of solids, liquids and gases to 10,000 F. (Fig. 4).

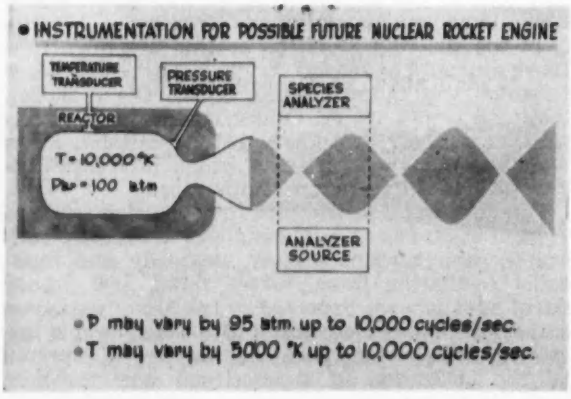


Fig. 4—Illustrating possible instrumentation in the form of temperature and pressure transducers and species analyzer which will be needed for free flight vehicles

Complex mechanisms of reaction kinetics make necessary the determination of the instantaneous species existing in combustion chamber and exhaust jet for a complete understanding of operation and performance. The free flight outside the atmosphere and away from fiducial objects will require devices for measuring in-flight thrust and an accurate integrating accelerometer to utilize this information to determine the vehicle's velocity and location.

For rapid technical and scientific progress we need well-planned and executed research based on a sound philosophy. Because we have lacked this, progress has been relatively slow. Such a philosophy must (1) conform to modern requirements, rather than medieval concepts, and (2) follow the basic procedure of putting the cart before the horse. The constant discovery of new facts and the refinements of measurements frequently dictate modification and even rejection of accepted but unproven axioms, and constant replacement with more exact ideas. Similar modifications are needed in the subdivision and classification of the sciences.

We suggest three subdivisions for the sciences—Life, Animated, and Inert. The first group would include all biological sciences, the second all propulsion sciences, and the third, all inert and otherwise basic sciences such as astronomy, chemistry, geology, mathematics, physics, petrology, etc.

The principal distinction between the first two groups is self-reproduction; between the first two and the third, the capability of organized motion. The first two groups are concerned with complete systems, while the third is limited to inert matter and dismembered parts of living or animated organisms. Such a classification indicates the close relationship between life and animated or propulsion sciences. The latter with its sensing devices, automatic controls and servomechanisms bears a close resemblance to a living organism.

In the past, complete separation of the propulsion system from the airframe has been adopted. Although it was accepted in principle that the airframe should be tailormade for the propulsion system, the reverse was usually followed. Modern and advanced philosophy suggests the following sequence of events:

a. Establishment of requirements.

b. Selection of fuel (propellants) to satisfy requirements.

c. Selection of engine to fit fuel and requirements.

d. Design of airframe around engine, fuel, and requirements.

Such a philosophy, while perhaps accepted in principle, has not formed the basis of our activities in the past. It will require great moral courage, effort, and ability to change us from relatively narrow-minded specialists into forward-thinking generalists for the solution of tomorrow's problems.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers.)

4 THINGS YOU'LL SEE IN

Trucks of Tomorrow

E. P. Lamb, Chief Engineer, Dodge Truck Division, Chrysler Corp.

Excerpts from paper "Some Factors Concerning Bodies and Related Components for Commercial Vehicles" presented at SAE Annual Meeting, Detroit, Jan. 12, 1953.

TRUCKS of tomorrow will be different! Exactly to what degree and precisely in what manner can hardly be predicted. However, some clue to things on the horizon can be gleaned from trends discernible today. Here are a few of the things you can expect to see:

1. Greater Front Axle Loading

Vigorous enforcement of axle load restrictions and an equally pressing need on the part of the trucker to haul maximum payloads are throwing great emphasis on load distribution.

Most trucks fail to load front tires to capacity and fall far short of approaching legal limits.

Increased application of power servo mechanisms to help steer will justify more front axle loading without increasing the driver's burden. This may result in shifting of load position through axle relocation.

By the time full advantage is taken of permissible front axle loads, the truck as we know it today will have undergone a considerable change in appearance.

2. Cleaner Cab Interiors

Simplification and elimination of levers, resulting from use of automatic transmissions, will further clean up cab interiors.

3. Air Conditioned Cabs

There are many truck operations where cab air conditioning could be considered in the search for a practical answer to the hot cab problem.

The equipment is somewhat costly, but its advantages seem great enough to offset this if operating cost can be kept within reason.

Successful air conditioning will require that body engineers provide a well insulated cab with a low infiltration rate.

4. Bodies of Plastic and Light Metals

A new era of light metals and man-made synthetics as body materials is approaching. Lighter weight, longer life, and more utility are what these materials offer.

Plastic body components, molded complete with structure, color, and finish are more than mere speculation.

With all these materials at hand—and with the help of the new production techniques which are constantly being developed—the body engineer stands today upon the threshold of unlimited possibilities.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

Europeans Take to

AIRCOOLED diesel engines are being successfully built in Europe to meet a wide variety of automotive and industrial uses. Cooling problems have been solved so satisfactorily, in fact, that:

1. Specific output and specific fuel consumption are comparable to those of similar combustion systems in watercooled engines.
2. Wear rate is less than that of liquid-cooled engines when operated on fuels of equal grade and quality.
3. Overall length and height dimensions can be maintained equal to or less than those of liquid-cooled engines of equal displacement when the space requirement of the radiator is included.
4. Cold weather starting characteristics compare favorably with those of liquid-cooled engines.

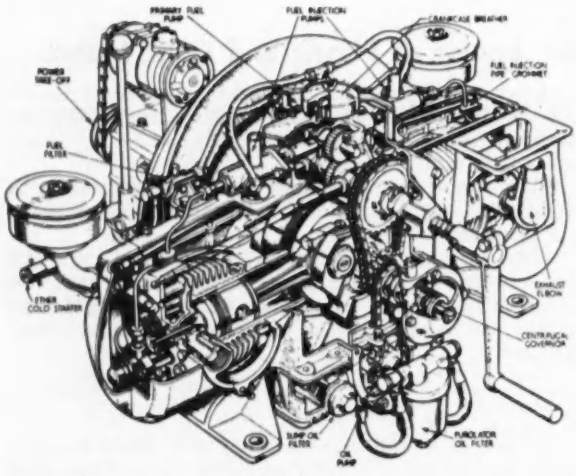
To achieve these results, European builders have, with one exception, used a 4-cycle engine. In most respects, however, the similarity between various makes of engines ends here.

Cooling systems, for example, are different for almost every engine. And combustion chambers appear in a variety of shapes—both offset to the side of the cylinder and built into the piston or cylinder head.

With these overall thoughts in mind, let's take a look at specific features of various European aircooled diesel engines. . . .

SWISS Locomotive Works' 4-cycle aircooled diesel engine has a number of unique features.

• Each combustion chamber is of toroidal configuration and is placed somewhat eccentrically in the piston head.



Swiss Locomotive Works' 4-cycle aircooled diesel engine

• Each cylinder head is an outstanding example of foundry craftsmanship. This one casting contains the inlet and exhaust passages, the bore for the fuel injector, an indicator opening, ribs sufficient to carry off the heat and air passages affording ample air flow—all within a space limited by engine length requirements.

• The aircooling system is especially interesting. On the intake side of the engine, a cast aluminum cover serves to enclose the cylinders and to distribute the cooling air. In front, this cover joins into the axial-flow blower housing and at the rear, into the air cleaner housing.

Cooling air is conducted through a diffuser to an oil cooler with metal fins, then it is deflected at 90 deg to the axis of the engine past each cylinder and head. It discharges on the exhaust side. Dampers reduce the cooling air flow as required.

Air for combustion is taken from the cooling air stream through an integral air cleaner. The pressure head in the cooling air duct overcomes the drop through the air cleaner. The slight supercharge provided at the inlet ports insures good scavenging and high volumetric efficiency.

• Unusually low specific fuel consumption and high bmep are other features of this engine. Output compares favorably with that of watercooled diesel engines.

Aircooled Diesels

Wayne H. Worthington, John Deere Waterloo Tractor Works

Based on paper "Contemporary European Air Cooled Diesel Engine Practice" presented at SAE Annual Meeting, Detroit, Jan. 13, 1953. Complete paper is available in multilithographed form from SAE Special Publications Department. Price: 25¢ to SAE members; 50¢ to nonmembers.

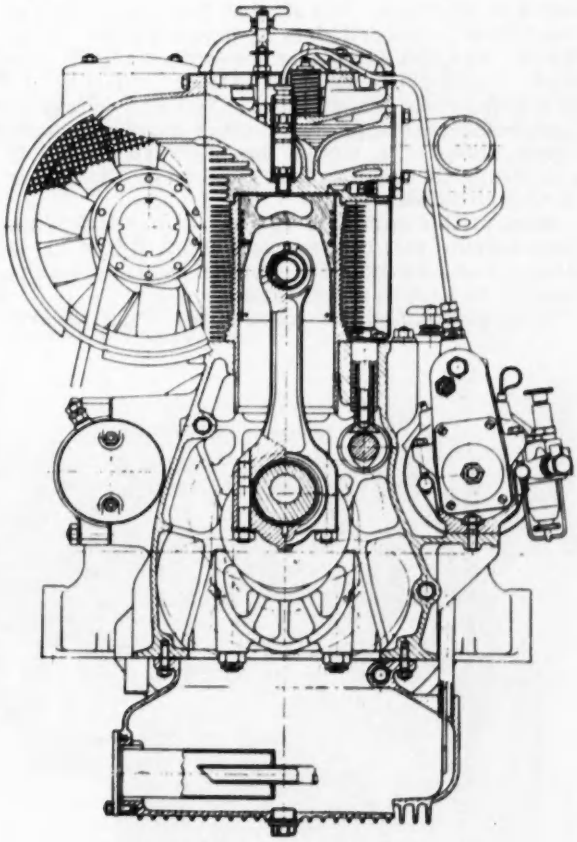
BRITISH Enfield twin-cyl aircooled diesel engine is cooled by air supplied by centrifugal fans cast integral with the flywheel. The cooling is intended to be ample for tropical conditions with ambient air temperatures up to 130 F.

The engine has a stroke of 3.937 in. and bore of 3.365 in. to go with its displacement of 63.3 cu in. Compression ratio is 19.5 to 1. Speed range is from 1200 to 1800 rpm, with specific fuel consumption at 1500 rpm being 0.41 lb/hp-hr. Bmep at maximum rating is 95.5 psi. Piston speed at 1800 rpm is 1180 fpm. The net weight of the engine with accessories is 310 lb.

The cylinders are heavily finned with low-expansion aluminum alloy. Cast-in gray iron liners are used. The cylinder heads are heavily finned with low-expansion aluminum alloy. Each has a cast-in combustion chamber, valve seats, and inlet and exhaust ports of special iron. Each piston of low-expansion silicon-aluminum alloy has a full-floating pin, three compression rings, and two scraper rings. The top compression ring is chrome-plated. The fuel-injection system has pintle-type, single-orifice nozzles.

Rate of wear of cylinder walls is approximately 0.001 in. per 1000 hr. (Average wear in similar watercooled engines is from 50% to 100% higher, due to slower warm-up time.)

Starting may either be manual, with a decompression gear or with a 12-v starter. An ether starting aid can be used to insure easy starting under very cold conditions.



British Enfield twin-cyl aircooled diesel engine

Please turn page

GERMAN Deutz 4-cyl aircooled diesel engine has a divided combustion chamber, with a pear-shaped "swirl" chamber comprising approximately 60% of the total compression space. This chamber is placed slightly to one side of the cylinder at an angle of about 30 deg to the cylinder axis.

The fuel injectors are also inclined relative to the cylinder axis. They are positioned in the intake end of the cylinder cowling in such a way as to receive the full flow of cold air entering from the blower duct. The main portion of the fuel spray is directed toward the throat of the chamber, with only a small portion impinging on the walls.

The glow plug for each cylinder is so arranged that it is not adversely effected by attack of hot combustion gases.

Each cylinder is tightly fitted to the cylinder head so that both parts can be removed from and assembled to the crankcase without damaging the cylinder-head gasket. There are 28 annular cooling fins per cylinder.

The aluminum-silicon alloy pistons have flat crowns. Each piston is provided with three pressure rings and two lap-joint scraper-type oil rings, one above and one below the fully floating piston pin.

The engine has an axial blower which delivers approximately 2560 cfm of cooling air at an engine speed of 2250 rpm. The air flow from the blower is conducted to the cylinders by tapering sheet-metal ducts. No deflecting plates are employed inside the duct. Guide plates attached to the cylinders insure satisfactory air distribution. Contrary to widely held opinions, the power absorbed by the fan and water pump of a similar liquid-cooled engine is practically the same as that required by the blower of this aircooled engine.

Bore of this engine is 4.33 in. Stroke is 5.51 in. Best specific fuel consumption, 0.407 lb/bhp-hr, is attained at 1250 rpm. Specific fuel consumption increases to 0.425 lb at 1700 rpm.

This specific fuel consumption is not particularly impressive when compared with that of some modern direct-injection engines, particularly those using a toroidal combustion chamber. However, proponents of divided combustion chambers appear willing to sacrifice some measure of economy in return for these claimed advantages over direct-injection engines:

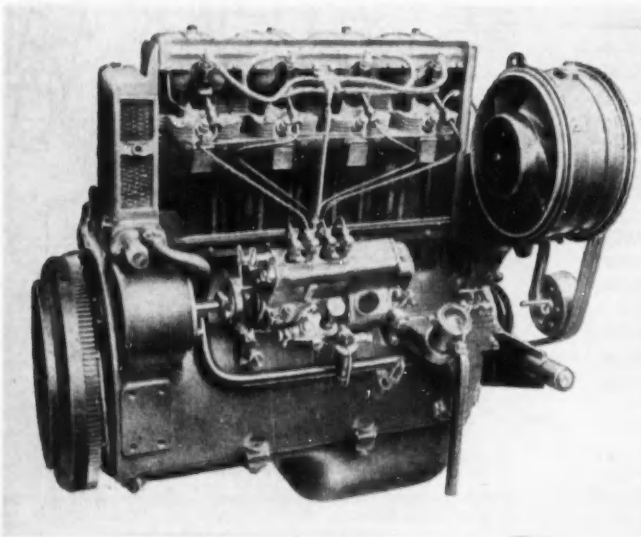
1. Larger valves, made possible by swirl-chamber design, maintain high volumetric efficiency in the higher operating speed range, within the limits of clean exhaust.
2. Greater smoothness at low speed and light loads.
3. Pintle-type nozzles with single large holes are less sensitive to carbon formation than the multi-hole nozzles of injection engines.
4. Less sensitivity to different grades of fuel, particularly those with a high sulfur content.

The highest thermal strain to which this engine is subjected coincides with maximum output. Therefore, since maximum engine speed can be kept under control by the speed governor, overheating is unlikely to occur.

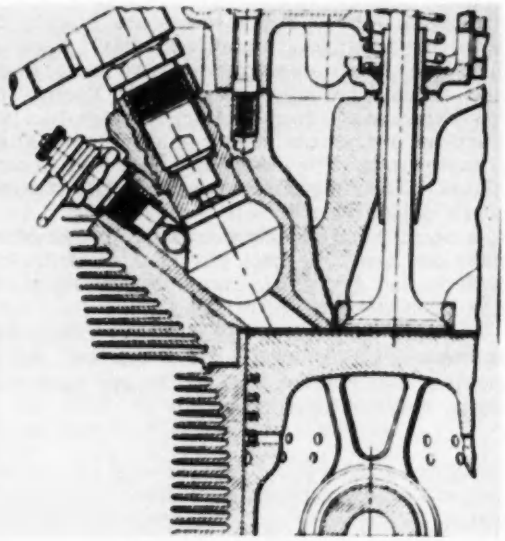
The engine is fitted with positive crankcase ventilation. This is part of the reason why cylinder life between reconditioning intervals is about double that of its prewar watercooled forefather. Use of materials with better wear characteristics is a second contributing factor to less wear.

The engine behaves extremely well in extreme temperature climes. At temperatures of −40 F, it can be started after application of a blowtorch for 10 min and preheating the swirl chambers for 1 min. Total time required to get the engine ready to move the vehicle is only 1/3 that necessary for water-cooled engines under these conditions.

The engine is also highly efficient and reliable at high temperatures. An engine has been operated at full speed and full load for 2 hr in an ambient temperature of 140 F without excessive overheating.



German Deutz 4-cyl aircooled diesel engine



Deutz swirl-type combustion chamber

Panel Answers Questions on Manufacturing



Turbine Engine Blading

C. C. Clark, Thompson Products, Inc.

Based on secretary's report on Panel on Jet Engine Buckets and Blades held as part of the Aeronautic Production Forum at the SAE National Aeronautic Meeting, New York, April 20, 1953. Panel leader was W. M. Williams, Jet Engine Division, Thompson Products, Inc.

Forgings

Question: What factors should be considered when choosing between precision and rough forgings?

Answer: The type of material, quantities involved, surface finish required, tolerances, and price should all be considered.

In general, parts machined from rough forgings will meet closer tolerance requirements than precision forgings. However, precision forgings can be held to tolerances of 0.007 in. on contour and ± 0.0075 in. on thickness in production. Tighter tolerances can be held, but only at the expense of higher tool and die costs.

It is necessary to maintain tool, die, and lubricant cleanliness to insure good surface finish on precision forgings. This is not critical on rough forgings since stock is removed in finishing. Companies that use both precision forgings and machined rough forgings seem to like the two methods about equally well.

Question: In precision forging what shape do you start with before coining to obtain the final dimensions?

Answer: The shape before coining is very similar to the coining dies. Other forms have been tried but with very little success. However, English forging manufacturers have been able to coin dissimilar shapes into final form by the use of large presses and extreme pressures.

Question: How can twist and bow in blades be controlled?

Answer: Twist and bow in blades under 5 in. in length and 1 in. in chord width are usually not problems. Most of the trouble can be eliminated by careful removal of the part from the forging dies and by close attention to the straightness of heat-treat fixtures. Some success has been achieved with die or fixture quenching. It is hard to suggest cor-

rective measures for this problem because each part behaves differently.

Question: Has cold straightening been successful with AISI Type 403 or 410 stainless steel blades?

Answer: Yes, it's fairly common practice with these.

Question: What are the common forging lubricants?

Answer: The lubricant used in high-temperature forging is usually colloidal graphite in water. In the case of aluminum, lard is generally used.

Question: Has any work been done on the nitriding of dies?

Answer: Not enough to evaluate the process fully.

Question: What is the future of impact forging?

Answer: Considerable work has been done recently on this type of forging. Some of the early commercial machines had certain drawbacks such as poor feed and positioning mechanism and no provision for heating of dies. In some of the newer installations, these drawbacks have been corrected and a more satisfactory unit produced. There is some doubt as to the feasibility of precision forging by the impactor method.

Question: Will forging to size cause excessive grain germination in Nimonic 80A alloy?

Answer: Control of grain germination requires a careful control of the percentage deformation, temperature, and time at temperature.

Under 5% deformation per blow increases the tendency to form large grains. It has been found useful to leave the final forging slightly oversize (0.010 in. envelope) to permit etch testing for grain size.

One forging vendor has noticed definite evidence of heat variations in grain size. His tests were incomplete, and further work along this line might be beneficial.

Question: What is the minimum trailing edge thickness that can be obtained by forging blades from Nimonic 80A?

Answer: A thickness 0.015 in. can be met, but for large production runs 0.030 in. is more practical because of tooling life.

Question: How does the surface condition of Waspaloy compare with that of S-816?

Answer: The surfaces are comparable. Some difference in forging techniques is required. S-816 is a little easier to forge, probably because we've had more experience with it and know better how to handle it. Maybe as background with Waspaloy is built up, we'll find it's just as easy to forge.

Question: How do Waspaloy and S-816 compare as to consistency of grain size?

Answer: In general, S-816 has been found to be more consistent.

Question: Should scrap metal be used in the manufacturing of Waspaloy?

Answer: The specifications require that virgin material be used.

Question: How do you determine whether to forge or cast?

Answer: In many cases the answer is simple since some of the high-temperature alloys cannot be forged. In other cases such as the 410-type alloys the casting difficulties are such that it is more economical to forge. Another consideration is the physical properties required. Forgings generally have better mechanical properties than castings. As in the choice between sand and precision castings, the cost of finishing must be considered. In some cases, very intricate shapes can be produced by precision casting with very little finishing required.

Castings

Question: What are normal precision investment casting tolerances?

Answer: A tolerance of ∓ 0.006 in. per in. is usually held. This will vary somewhat with the size and configuration of the part.

Question: Is it feasible to cast blades or buckets integral with the disc?

Answer: This depends on the tolerances and repair work permissible. If it is frequently necessary to scrap an entire assembly because of a small defect on one blade or bucket, the cost usually becomes prohibitive.

Question: Can titanium be cast?

Answer: Very little commercial work has been done in the casting of titanium because of its high melting point and extreme affinity for oxygen and nitrogen. All casting would have to be done in a vacuum under carefully controlled conditions it appears now.

Special Fabricating Techniques

Question: Where is the **powder metal blade** used and what are its relative properties?

Anwer: The powder metal blade has been used for compressor rotor and stator blades. It has an average tensile strength of over 100,000 psi, which is somewhat lower than the stainless steel blade but considerably higher than bronze or aluminum blades. The damping capacity characteristics of the blade are quite good and permit it to withstand extreme vibrational stress.

Question: Has any work been done on **extruding hollow nozzle vanes?**

Answer: The practice is not widespread. However, some work has been done on deep drawing to form a hollow cylinder and subsequent pressing to form a hollow nozzle vane.

Question: Has there been any application of the **electroforming process** to the production of hollow blades?

Answer: Not that we know of. Cost and difficulty of alloy deposition discourage application of the method.

Question: What are the **advantages of sheet metal blades?**

Answer: Sheet metal blades usually save weight and are easier to cool.

Question: On sheet metal blades, what are the **methods of controlling springback?**

Answer: Some manufacturers hold the formed sheets in a cooled copper welding fixture during welding. Others use low-melting plugs during the forming operations.

Question: What has been the experience with **resistance welding?**

Answer: The anvil life is usually very poor because of the localized high pressure. The use of carbide inserts in the anvil face does not help appreciably because the inserts crack readily. This method presents no advantages over other forging techniques.

Question: What are the **advantages of cermets** for blades or buckets?

Answer: The cermets have excellent strength/weight ratio and heat resistance, and are somewhat lighter in weight than the usual high-temperature alloys. Their impact resistance is somewhat low because of low ductility. It is easily possible that future applications will be found for these materials.

On the panel for the panel discussion at which the accompanying questions and answers were voiced were:

Panel leader:
W. M. Williams, Thompson Products, Inc.

Panel secretary:
C. C. Clark, Thompson Products, Inc.

Panel members:
P. C. Ambrose, Pratt and Whitney Aircraft
C. P. Brooks, Austenal Laboratories, Inc.
R. L. Grunewald, General Electric Co.
E. H. Jones, Ex-Cell-O Corp.
L. M. Raring, Utica Drop Forge and Tool Corp.
J. V. Rickard, Curtiss-Wright Corp.

The complete report on the discussion is available in multilithographed form together with reports of the nine other panel sessions of the 1953 SAE Aeronautic Production Forum. This publication, SP-302, is available from the SAE Special Publications Department. Price: $2 to members; $4 to nonmembers.

Question: Has any use been made of **ceramic coatings over low-alloy** blade and bucket materials?

Answer: This is a fairly new field where considerable experimental work is being done. Ceramic coatings are being tried not only on buckets and blades but also on combustion chambers and cones. This application presents the possibility of reducing the alloy content on many parts, and research will undoubtedly be continued.

Surface Finishing

Question: What are the most satisfactory **methods of removing scale?**

Answer: Many companies find sand and grit blasting are quite adequate. Others prefer continuous tumbling with an acid-type compound. A few have obtained satisfactory results with the hydride descaling process.

Question: What are the usual methods of obtaining adequate **surface finish on the airfoil?**

Answer: The two most common methods are continuous tumbling and longitudinal micro polish by

one of the commercially available machines. In the case of machined blades, the machined surface is usually satisfactory.

Question: What is the **preferred tumbling method?**

Answer: Continuous wet tumbling gives very good results. Consideration of proper ratio of load to stones and compound has reduced the nicking problem to a minimum and produced very satisfactory surface.

Question: Are there any methods of **preventing the black surface** indications appearing on anodized aluminum parts?

Answer: These indications do not react to Zyglo inspection and are apparently a very superficial surface condition. It has been almost universally observed, but no one has solved the problem completely. The only solution known is to polish lightly to remove the indication and then reanodize.

Question: How can the **scale on titanium** be removed?

Answer: Surface forging scale can be removed by blasting. The oxide surface is a very tenacious scale and is very difficult to remove. All heating should be done in controlled atmospheres to reduce oxide formation as much as possible. Most forging manufacturers remove only the surface scale and permit the oxide to remain on the surface until all forging is complete. Then they remove this surface in the finishing operations.

Question: Are **titanium alloys** hard to machine?

Answer: After the first preliminary work no more machining difficulty has been experienced with titanium alloys than with the more common alloy materials. The titanium alloys do, of course, differ in machinability.

Question: What methods are used to **obtain the fir-tree configuration** on the roots of buckets?

Answer: Broaching and grinding are used almost universally to obtain the fir tree. S-816, Nimonic 80A, Inconel X, titanium, and AISI Type 403 stainless are examples of materials that are being broached successfully. Certain of the cast high-temperature alloys give difficulty in broaching and are usually ground. Grinding is more accurate, but the cost is higher.

Question: What is the **optimum grinding speed** for greatest stock removal on Nimonic 80A?

Answer: It has been found that the greatest stock removal with belt grinding occurs at a speed of approximately 3600 surface ft per min.

Question: Does surface treating lengthen **broach life?**

Answer: Surface treatments like nitriding, electrolyzing, and chromium plating have been tried, but no appreciable benefit has been derived. Of much more importance is the broaching speed, feed, and tool material and finish. Correct fixturing is also very important. In general, as the alloy content of the material being broached increases, the broaching speed should decrease.

Question: What is the best method for producing the **root radius** on compressor blades?

Answer: Except where the draw is too deep, the radius can be forged to specifications. In extreme cases, it has been possible to grip the blade airfoil in split precision dies and perform a heading operation on the root. The root radius can also be produced by use of a belt polisher or by grinding with a cam-follower arrangement.

Question: What are the relative merits of **mechanical, optical, and air gages?**

Answer: Most companies use the mechanical guillotine gage for production airfoil inspection. The optical and air gages are used for prototype checking, percentage checking, and receiving inspection. The guillotine gage gives the only complete picture of the airfoil since it provides a complete envelope. Wide flat blades cause considerable difficulty in checking by air or optical gages.

Air and optical gages are a relatively new development in the inspection field. More development and familiarity with their potential will probably increase their use.

Question: Has hard surfacing of **guillotine gage templates** been tried?

Answer: Some work has been done along this line with moderate success. Chromium plate has been tried on the contours and ways. However, in most cases it was found that the gages go out of standardization for reasons other than wear.

Question: Is the **tracing method** satisfactory for checking production airfoils?

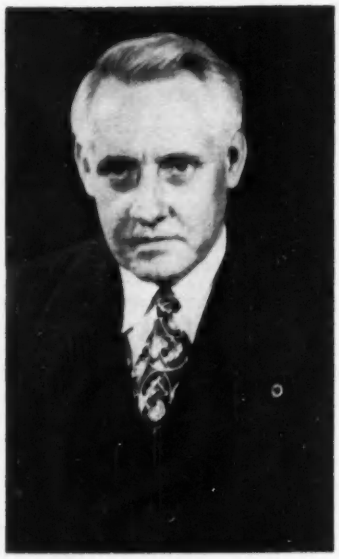
Answer: Using a stylus and standard templates to check nozzle vanes in production gives good results. The method is economical to operate and maintain.

NEWS OF SAE

pages 81–92

IOWA EDITOR . . .

. . . named 1953 Beecroft Lecturer



W. Earl Hall

W. EARL HALL, editor of the Mason City Globe-Gazette, will receive the Beecroft Memorial Award and present the 1953 Beecroft Lecture on October 19 during the National Safety Congress in Chicago. Beecroft Award Committee Chairman J. N. Bauman will make the award.

This seventh Beecroft Lecture will be published as a monograph by SAE and made available for widespread distribution as were the preceding Lectures. The Award is made annually for "substantial contributions to the safety of traffic involving motor vehicles," and originated in the terms of a $2500 bequest by the late David Beecroft, SAE president in 1921.

Previous awards were made to Paul G. Hoffman, chairman of the board of Studebaker Corp. and past-chairman of the Automotive Safety Foundation; Thomas H. MacDonald, formerly Commissioner, U. S. Bureau of Public Roads; Chief Justice Arthur T. Vanderbilt of the New Jersey Supreme Court; Sidney Williams, formerly assistant to the president of the National Safety Council; Rudolph F. King, registrar of motor vehicles of Massachusetts; and Franklin M. Kreml, director of the Traffic Institute of Northwestern University.

This year's Beecroft Lecturer has served on numerous committees in many fields; in the safety area alone, he was founder of the Iowa State Safety Council; vice-president (and presently member) of the National Safety Council; chairman of the National Committee for Traffic Safety; and chairman of the Public Support Committee of the President's Highway Safety Conference.

He was born in Iowa and got his B.A. from University of Iowa. He joined the editorial staff of the Milwaukee Journal after serving in World War I, and the next year, at 22, became managing editor of the Globe-Gazette.

Hall holds an LL.D. from Cornell College. He was one of 14 American journalists on a fact-finding mission to defense areas of Europe, Asia, and Africa in 1952. His once-a-week commentary, "One Man's Opinion," is heard on KGLO and other stations.

Manly Medalists . . .

. . . R. E. Gorton and B. E. Miller will receive their awards at Friday evening session of SAE Aeronautic Meeting, Oct. 1-3, in Los Angeles.

THE Manly Memorial Award will go to Robert E. Gorton and Bruce E. Miller, both of Pratt and Whitney Aircraft. E. G. Haven will present a Manly Medal to each at the Friday evening, Oct. 2, session of the SAE National Aeronautic Meeting in Los Angeles.

The Manly Award honors "the author of the best paper relating to theory or practice in the design or construction of, or research on, aeronautic powerplants or their parts or accessories which shall have been presented at a meeting of the Society or any of its Sections during the calendar year."

Gorton and Miller's winning paper was "Instrumentation for Aircraft Gas Turbine Development," which they presented at the SAE Annual Meeting, January 1952. In it, they describe special devices for measuring angular velocity, shaft runout, blade clearance, vibration frequency and amplitude, blade and disc temperatures, fluid temperatures and pressures, combustion gas components, and other variables.

The paper appears in full in the 1953 SAE Transactions. An abridgment of the paper appeared on pages 60-65 of the July 1952 SAE Journal.

The paper was selected for the award by the Manly Memorial Medal Board of Award. Board members are E. G. Haven, chairman; G. W. Brady; and R. R. Higginbotham.



R. E. Gorton



B. E. Miller

Plan Approved to Spread 1954 Annual Meeting

THE technical program of the SAE 1954 Annual Meeting will be distributed equally between the Sheraton-Cadillac and Statler Hotels in Detroit, according to the plan approved by the SAE Meetings Committee at its June 10 meeting in Atlantic City. Decision to spread the meeting was made to relieve congestion and provide additional facilities urgently needed for technical sessions, committee meetings, engineering display, and hotel sleeping rooms.

As indicated by the accompanying schedule, the technical sessions of six SAE Professional Activities have been allocated to each of the two hotels. The Annual Meeting Dinner again will be held in the Detroit Masonic Temple. This schedule is published at the request of the Meetings Committee to assist members in making suitable hotel reservations sufficiently in advance of the meeting.

The objective in developing this schedule to spread the meeting was to satisfy four requirements:

(a) To schedule complementary sessions consecutively in the same room. For example: Transportation and Maintenance and Truck and Bus; Aircraft Powerplant, Aircraft, and Air Transport.

(b) To schedule simultaneous sessions so as to avoid serious conflicts.

(c) To schedule the best attended sessions in the largest meeting rooms.

(d) To schedule sessions in accordance with a rotation plan which specifies that an Activity will not hold its sessions on the last day of the meeting more often than once in every four years.

Committee meetings that complement technical sessions moved to the Hotel Statler also will be transferred. For example: All Activity Committee meetings of the Engineering Materials, Body, Tractor and Farm Machinery, Aircraft Powerplant, Aircraft, and Air Transport will be scheduled at the Hotel Statler, as probably will the meetings of technical committees operating in these fields. By the same token the committee meetings of the other six Professional Activities and of complementary technical committees will remain at the Sheraton-Cadillac where their technical sessions will be held.

As further assistance to members planning to attend the 1954 Annual Meeting, the tentative program of the meeting will include for the first time a preliminary list of committee meetings.

The Engineering Display will be continued in the Sheraton-Cadillac and will be expanded to increase the number of display booths from 47 to 69.

To facilitate travel between the two hotels, an SAE charter bus will shuttle back and forth between them.

Suggested Session Schedule . . .

. . . for 1954 Annual Meeting at Sheraton-Cadillac and Statler Hotels, and Masonic Temple, Detroit.

	LOCATION	MONDAY, JAN. 11	TUESDAY, JAN. 12	WEDNESDAY, JAN. 13	THURSDAY, JAN. 14	FRIDAY, JAN. 15
MORNING	SHERATON-CADILLAC	TRUCK AND BUS	TRANSP. AND MAINT.	PASSENGER CAR	FUELS AND LUBRICANTS	DIESEL ENGINE
	STATLER	ENGINEERING MATERIALS	ENGINEERING MATERIALS	AIRCRAFT POWERPLANT	AIRCRAFT / AIRCRAFT	AIR TRANSPORT
AFTERNOON	SHERATON-CADILLAC	TRANSP. AND MAINT.	TRUCK AND BUS	PASSENGER CAR	FUELS AND LUBRICANTS	DIESEL ENGINE
	STATLER	BODY	TRACTOR	AIRCRAFT POWERPLANT	AIRCRAFT / AIRCRAFT	
EVENING	AS INDICATED	STATLER, GBR / BODY	SHERATON-CAD. GBR / PRODUCTION	MASONIC TEMPLE / DINNER	STATLER, GBR / AIR TRANSPORT	

SHERATON-CADILLAC STATLER MASONIC TEMPLE

Program for

SAE National Aeronautic Meeting

Aircraft Production Forum and Engineering Display

Sept. 29 – Oct. 3, 1953 ***Hotel Statler, Los Angeles***

Production Forum—Pages 84-85 . . . Technical Sessions—Pages 86-87

Tuesday and Wednesday
Sept. 29-30
AIRCRAFT PRODUCTION FORUM
"Greater Air Power Per Dollar"

Sponsored by SAE Production Activity
Sponsor: B. C. MONESMITH
General Chairman: B. A. WILLSEY

Nine separate informal gatherings to exchange information and experience on vital aircraft production problems, with the object in mind of trying to cut production costs and to stretch the production dollar. Each discussion will be sparked by a panel of experts.

The topics to be discussed by each panel are listed in the order in which they will be discussed, both morning and afternoon.

8:00 a.m.—Both days Ballroom Floor
Room Locations will be listed at Registration Desk

Tuesday, Sept. 29

QUALITY CONTROL

Panel discussion will deal with costs of Receiving Inspection; reliability; time-saving techniques and equipment; development of inspection tools; preparation and use of standard hours in inspection operations; pre-planning of inspection procedures.

9:00 a.m.—11:30 a.m.

Effects of Product Reliability on Costs

1. Volume and costs of Receiving Inspection (Is the aircraft industry spending excessively for Receiving Inspection?)
2. Quality Control, as related to functional problems of electronic and other equipment
3. Latest techniques and equipment for Inspection use (Rotab set-ups. Ultrasonic inspection devices, etc.)

2:00 p.m.—4:30 p.m.

Costs Benefits in pre-planning of inspection by Quality Control

1. Development of tools for inspecting the product
2. Quality and Serviceability of the Product (At what point and by what method is it determined that a product has good quality and serviceability aspects?)
3. Development and use of standard hours for inspection operations

Panel Leader:
R. S. Catlin, Director, Quality Control, Northrop Aircraft, Inc.

Panel Co-Leader:
G. A. Covington, Manager, Quality Control, Consolidated Vultee Aircraft Corp.

Secretary:
R. H. Hopkins, Statistical Quality Control, Northrop Aircraft, Inc.

Panel Members:
D. A. Hill, Director, Quality Control, Hughes Aircraft Co.
R. F. Martin, Chief Inspector, North American Aviation, Inc.
W. C. Hitt, Assistant Chief, Quality Control, Douglas Aircraft Co., Inc., Santa Monica
E. S. Barnhart, Quality Control Manager, Solar Aircraft Co.

FORMING

A review of present-day manufacturing techniques and discussions on different approaches to problems in forming new materials and part configurations inherent in new design trends.

9:00 a.m.—11:30 a.m.

1. Forming with rubber (High-pressure applications—hot forming—container problems)
2. Aircraft draw forming (Techniques—problems)

2:00 p.m.—4:30 p.m.

1. Stretch Forming (Techniques—problems—hot applications)
2. Forming sculptured and integrally stiffened members and new forming techniques (Die quenching metallic shot and shot peen forming, high-pressure fluid applications, brake and roll forming)

Panel Leader.
J. S. Corral, General Foreman—Machine Forming, North American Aviation, Inc.

Panel Co-Leader:
D. W. Kraybill, Assistant Factory Manager, Tooling Operations, Northrop Aircraft, Inc.

Secretary:
R. E. Furgeson, Industrial Engineer, North American Aviation, Inc.

Panel Members:
H. C. Emerson, Tool Superintendent, Rohr Aircraft Corp.
E. E. Carpenter, Supervisor, Manufacturing Research, Boeing Airplane Co., Seattle
F. C. Hoffman, Manufacturing Research Engineer, Lockheed Aircraft Corp., California Division
J. A. Cole, Tool Project Engineer, Douglas Aircraft Co., Inc., Long Beach

MATERIAL HANDLING

Handling of parts and materials throughout a manufacturing cycle must be constantly improved. How to make some of these improvements, and the planning and operational problems involved, will be discussed by this panel.

9:00 a.m.—11:30 a.m.

1. Material flow pattern in relation to plant layout
2. Internal and external transportation
3. Standardization of handling equipment

2:00 p.m.—4:30 p.m.

1. Mechanized movement of parts and materials
2. Floor and overhead handling equipment
3. Parts protection (Protective coatings and other methods)

Panel Leader:
A. C. Wallen, Tooling Manager, Douglas Aircraft Co., Inc., Long Beach

Panel Co-Leader:
J. E. Van Dorn, Superintendent—Warehousing, Northrop Aircraft, Inc.

Secretary:
Fred Bassick, Facilities Engineer, Douglas Aircraft Co., Inc., Long Beach

Panel Members:

R. L. Clark, Methods Engineering Manager, Ryan Aeronautical Co.
R. F. Hurt, Chief Project Planner, Lockheed Aircraft Corp.
Fred Wythe, Supervisor, Industrial Engineering, North American Aviation, Inc.

Wednesday, Sept. 30

CONTROL OF MANUFACTURING COSTS

A discussion of pre-production activities and the establishment of means of control as a foundation for meeting schedules at minimum cost. Remarks will be confined to principles. The panel will not discuss definitions or debate the relative merits of the practices and procedures of individual companies.

9:00 a.m.—11:30 a.m.

1. Control of Basic Programming and Scheduling
2. Control of Engineering Schedule
3. Development and Control of the Plan for Manufacture
4. Measurement of Pre-Production Performance

2:00 p.m.—4:30 p.m.

Discussion of specific means for controlling manufacturing costs

1. Control of Design Relative to Production Costs
2. Control of Planning and Tooling Expenditures
3. Control of Fabrication and Assembly Costs
4. Control of Cost of Materials Including Subcontractor Cost Performance

Panel Leader:

J. T. Gray, Assistant to the Manufacturing Manager, Lockheed Aircraft Corp., California Division

Panel Co-Leader:

K. P. Bowen, Vice President—Manufacturing, Northrop Aircraft, Inc.

Secretary:

N. B. Davis, Jr., Supervisor, Manufacturing Statistics, Lockheed Aircraft Corp., California Division

Panel Members:

H. J. Brown, Chief Accountant, Lockheed Aircraft Corp., California Division
Morrie Harper, Supervisor, Cost Analysis and Standards, Douglas Aircraft Co. Inc.—El Segundo
Kermit Stegen, Supervisor, Production Analysis, Scheduling Department, North American Aviation, Inc.
E. S. Buffa, School of Business Administration, University of California at Los Angeles

ECONOMICS OF TOOLING

The panel will discuss information on the major items that affect overall tooling economy. These items will come under two main categories as shown.

9:00 a.m.—11:30 a.m.

How today's designs affect the economics of tooling

1. Performance requirements of today's aircraft
2. New materials and methods of fabrication of today's aircraft

2:00 p.m.—4:30 p.m.

How today's contract requirements affect the economics of tooling

1. Schedules
2. New specifications
3. Rate and quantity of aircraft
4. Provisions for insurance programs

Panel Leader:

C. S. Glasgow, Chief Tool Engineer, Douglas Aircraft Co., Inc., Santa Monica

Panel Co-Leader:

S. N. Bean, Chief Tool Engineer, Lockheed Aircraft Corp., California Division

Secretary:

K. H. Boucher, Administrator, Tool Engineering, Douglas Aircraft Co., Inc., Santa Monica

Panel Members:

G. A. Evans, Tooling Manager, The Glenn L. Martin Co.
R. A. Fuhrer, Chief Tool Engineer, Consolidated Vultee Aircraft Corp.
A. L. Hilleland, Works Manager, Willys Motors, Inc., Richmond Machining Division
J. S. Semprez, Chief Tool Engineer, Douglas Aircraft Co., Inc., El Segundo
B. D. Shepherd, Chief Tool Designer, North American Aviation, Inc.

PLANT LAYOUT AND PLANT ENGINEERING

The objectives of plant layout and plant engineering are: effective provisioning, utilization and maintenance of plant facilities erected and arranged to allow for the manufacture of a quality product on time and at the least total cost.

9:00 a.m.—11:30 a.m.

The economic problems of plant layout and plant facilities

1. Effect on product cost
2. Impact on plant engineering
3. Initial investment vs. rehabilitation and maintenance

2:00 p.m.—4:30 p.m.

Basic considerations for cost reduction

1. Standardization of layout and equipment
2. Maintaining and improving utilization of space and facilities
3. Developing methods of measuring effectiveness of plant layouts and plant engineering

Panel Leader:

H. W. Linton, Chief Industrial Engineer, North American Aviation, Inc.

Panel Co-Leader:

E. R. Petoskey, Assistant Plant Engineer, Northrop Aircraft, Inc.

Secretary:

J. A. Maurice, Manufacturing Engineer, North American Aviation, Inc.

Panel Members:

R. D. Marks, General Supervisor, Manufacturing Planning, Consolidated Vultee Aircraft Corp.
C. H. Brubaker, Assistant Plant Manager, Hughes Aircraft Co.
V. N. Ferguson, Chief Industrial Engineer, Temco Aircraft Corp.
J. P. McNamara, Plant Engineer, North American Aviation, Inc.
A. C. Hamilton, Superintendent of Plant Layout and Equipment, Republic Aviation Corp.

CHANGE CONTROL

Change control provides an overall plan and schedule for the incorporation of a change in a product with a minimum of confusion and cost to the program.

9:00 a.m.—11.30 a.m.

1. Method of injecting design changes into production
   a. Type of changes
   b. Routine and expedited
   c. Cost and schedule

2:00 p.m.—4:30 p.m.

1. Method of effecting design changes into subcontractors' products
2. Method of verification of change incorporation in product (Inspection records, part number changes, letter changes, color coding, etc.)

Panel Leader:

N. H. Shappell, Manufacturing Control Manager, Douglas Aircraft Co., Inc., Santa Monica

Panel Co-Leader:

A. F. Kitchin, Production Manager, Rohr Aircraft Corp.

Secretary:

D. C. MacArthur, General Supervisor—Schedules and Change Control, Douglas Aircraft Co., Inc., Santa Monica

Panel Members:

J. R. Allen, General Supervisor—Schedules and Change Control, Douglas Aircraft Co., Inc., Tulsa
J. C. Derse, Administrative Assistant to Manager of Manufacturing Planning, AiResearch Manufacturing Co.
H. E. Herdrich, Assistant Manager, Industrial and Plant Engineering, Northrop Aircraft, Inc.
L. F. Lashley, Chief Project Coordinator—Patrol Series, Lockheed Aircraft Corp., California Division

PROCUREMENT

Procurement can be controlled to fit better into the general operations and effect a reduction in overall cost. The subjects to be discussed will offer a full day of worthwhile information.

9:00 a.m.—11:30 a.m.

1. Ramifications of Armed Service Procurement Regulations and their effect on the procurement policies of the contractors
2. Source Development; creation of new sources, the techniques used, the results obtained to date by the use of these techniques and the recommendations for better techniques
3. Policies and relations with subcontractors
   a. Methods of controlling contracts
   b. Maintenance of tool design and engineering information
   c. Obligations of prime contractors to subcontractors and, in turn, the subcontractors' obligation to the primes

2:00 p.m.—4:30 p.m.

1. Discussion of the various forms of assistance given by plane manufacturers to subcontractors
   a. General
   b. Technical
   c. Mechanical
2. Methods of assuring on-schedule receipts from vendors; follow-up of purchase orders and control of vendor schedules
3. Forging Procurement Problems. Heavy Press Program

Panel Leader:

A. R. Campbell, Purchasing Agent, Rohr Aircraft Corp.

Panel Co-Leader:

J. W. Hinchcliffe, Chief of Materiel, Northrop Aircraft, Inc.

Secretary:

C. R. Campbell, Purchasing Agent, Rohr Aircraft Corp., Riverside Division

Panel Members:

Howard Golem, Director of Procurement, Consolidated Vultee Aircraft Corp.
Frank Dobbins, Chief of Materiel, Boeing Airplane Co., Seattle
Brigadier General K. D. Metzger, Chief Production and Resources Division, AMC, Wright-Patterson Air Force Base
C. D. Collier, Chief of Materiel, Temco Aircraft Corp.

MACHINING

Panel will cover the role of manufacturing research in cutting production costs, advanced cutter design and application, problems arising with increased requirements for three dimensional machining, the machining of high strength steels, Titanium and Titanium alloys, control problems in machining massive aluminum forgings and a survey of the latest available machine tools.

9:00 a.m.—11:30 a.m.

A small investment in research can save a lot in production

1. Precision machining of turbine parts
2. Cutter design and three dimensional machining

2:00 p.m.—4:30 p.m.

Problems involved in special materials and products

1. Machining of integrally stiffened skins
2. Steels in the 280,000 lb. per sq. in. tensile class
3. Titanium and its alloys
4. Control of distortion in the machining of large aluminum forgings
5. New machinery now being offered and on the design boards

Panel Leader:

J. A. Logan, Chief Production Engineer, Solar Aircraft Co.

Panel Co-Leader:

J. R. Howard, Supervisor, Tool Standards, Rohr Aircraft Co.

Secretary:

H. W. Ingalls, Supervisor, Patent Department, Solar Aircraft Co.

Panel Members:

Frank Eppick, General Foreman, Machine Shop, Consolidated Vultee Aircraft Corp.
C. J. Harman, Assistant Staff Superintendent, AiResearch Manufacturing Co.
R. B. Scott, Supervisor, Manufacturing Research, Lockheed Aircraft Corp., California Division
F. M. Rayburn, Assistant Manager, Tooling Department, Menasco Manufacturing Co.

SAE NATIONAL AERONAUTIC MEETING AND ENGINEERING DISPLAY

TECHNICAL SESSIONS

Oct. 1-2-3

Thursday, Oct. 1

9:30 a.m. **Sierra Room**

Welcome to Los Angeles

F. O. Hosterman
General Chairman of Meeting

STRUCTURES

Chairman—**L. P. Spalding,**
North American Aviation, Inc.
Secretary—**D. E. Dawson,**
North American Aviation, Inc.

Design for Fatigue

E. H. Spaulding, Lockheed Aircraft Corp.
New aluminum alloys reveal no practical change in fatigue behavior. Use of gross area stress is mandatory in fatigue analysis and structure comparison. Maintenance helps, and x-ray inspection of blind areas is a promising tool.

Delta Wing Design Analysis

H. U. Schuerch, Aerophysics Development Corp.
New aircraft configurations, especially wing designs like the multispar delta, are unacceptable pending stress analysis. Research approaches include the experimental, amplification of simple beam concepts, and applications of matrix calculus and electrical analog networks.

Designing Aircraft Structure for High Temperatures

E. H. LaBombard, Douglas Aircraft Co., Inc.
Research discloses temperature sources and magnitudes in fast aircraft and missiles, plus effects upon materials. The heat problem involves design, choice of materials, insulation, and other factors essential to future applications.
(Sponsored by Aircraft Activity)

9.45 a.m. **Golden State Room**

Welcome to Los Angeles

F. O. Hosterman
General Chairman of Meeting

HIGH SPEED

Chairman—**R. W. Thaw,**
Douglas Aircraft Co., Inc.
Secretary—**R. W. Goodhart,**
Douglas Aircraft Co., Inc.

Design Considerations for Maneuverability of High-Speed Airplanes

B. G. Peterson, North American Aviation, Inc.
High speeds increase air loads, structural strength, weight. From the drafting-board stage, planes must have good lift capabilities, high performance, suitable control surfaces, satisfactory handling and flying qualities—all affecting maneuverability.

Taking Man to Higher Altitude

A. M. Maye, El Segundo Division, Douglas Aircraft Co., Inc.
Man's invasion of outer atmospheres creates new and different environmental problems. Some are solved; techniques developed for meeting others. Yet hazard probabilities mandate consideration of weight economy and simplification of instruments and controls.

Use of Air-Breathing Propulsion for High-Altitude Sounding Rockets and other Ballistic Missiles

J. W. Luecht, Chrysler Corp.
Is rocket propulsion alone suitable for high-speed ballistic vehicles? There's evidence that air-breathing propulsion's greater specific impulse may be superior. This paper presents new and comparable factors.
(Sponsored by Aircraft Activity)

2:00 p.m. **Sierra Room**

LANDING GEARS

Chairman—**J. I. Hamilton,**
Menasco Manufacturing Co.
Secreatry—**K. S. Carter,**
Lockheed Aircraft Corp.

Trends in Landing Gear Design on Modern Aircraft

W. E. Eldred, Consolidated Vultee Aircraft Corp.
Admission that what goes up must come down merely introduces the aircraft landing-gear problem. Design test techniques, and new materials, including ultra high-strength steel, definitely must be incorporated in future engineering conceptions.

Manufacturing Requirements for Producing the Modern Landing Gear

G. E. Beringer, Bendix Products Division, Bendix Aviation Corp.
Trends in landing-gear design herein are analyzed and interpreted in terms of changing facilities and manufacturing processes. The swing to lighter, more complex equipment demands manufacturing precision and close control.

High Temperature Brazing Applications

R. S. Mueller, F. J. Filippi, and **G. D. Cremer,** Solar Aircraft Co.
Corrosion - resistant, high - temperature brazing presages increasingly satisfactory, light, strong, and complicated metal assemblies for aircraft, automotive, and other uses. Unique process characteristics are evaluated.
(Sponsored by Aircraft Activity)

2:00 p.m. **Golden State Room**

FUEL SYSTEMS

Chairman—**J. B. Pitkin,**
Lockheed Aircraft Corp.
Secretary—**P. H. Jones,**
North American Aviation, Inc.

Tanker Aircraft Refueling Systems

T. R. Farrington, Power Plant Laboratory, Wright Air Development Center
There's more than meets the eye—or the nozzle—in transferring fuel in bulk between planes in flight. Problems begin with design, include energy losses, power requirements, pump installations, discharge pressure regulation.

Armed Services-Industry Cooperative Study of Aircraft Fuel Rating Methods

Commander D. L. Nowell, Navy Bureau of Aeronautics
Tests of 19 plus-100 octane aviation fuels in five American, two British, and laboratory powerplants outmode World War II ratings. Current data facilitate balancing performance with potential volume if compromise becomes necessary.

Fuel System Complexity—How Much is Necessary?

R. R. Higginbotham, and **W. R. Petersen,** Republic Aviation Corp.
What complicates flight-refueling of jet fighters? It looks as if specification requirements are 90% responsible. The authors insist weight can be saved, equipment simplified, without sacrificing utility.
(Sponsored by Aircraft Powerplant Activity)

8:00 p.m. **Golden State Room**

CONFIDENTIAL SESSION

Restricted to SAE Members and Personnel of U. S. Military Services and Government Agencies whose applications have been approved before the meeting by the Navy Bureau of Aeronautics—The session's sponsor.

Application blanks have been mailed to the SAE membership. Additional blanks may be obtained from SAE Headquarters, 29 West 39th Street, New York 18, N. Y., or the SAE Western Branch Office, 714 West Olympic Boulevard, Los Angeles 15, California.

Chairman—**J. B. Wassall,**
Lockheed Aircraft Corp.

New Developments in Carrier Landing Techniques

Captain Harry Sosnoski, Commanding Officer and Director, Naval Special Devices Center

Why Hydro-Skis?

F. H. Sharp, Consolidated Vultee Aircraft Corp.

Development of the High-Speed Aerial Drone

Bruce Smith, Ryan Aeronautical Co.
(Sponsored by Aircraft Activity)

Friday, Oct. 2

9:30 a.m. **Los Angeles Room**

ELECTRICAL

Chairman—**L. A. Wood,**
Boeing Airplane Co.
Secretary—**C. P. Steele,**
Boeing Airplane Co.

New Concept of Explosion Testing of Aircraft Equipment

W. K. Klose, Boeing Airplane Co.
It was mighty embarrassing when the explosion-proof pump started a fire! Subsequent flame-suppression research developed both new fire dangers and the inadequacy of test techniques. New approaches are suggested.

Cooling Electric Equipment During Supersonic Flight

D. C. Wells, Ryan Aeronautical Co.
Is forced air or liquid cooling preferable for aircraft interiors at supersonic speeds? The author describes the use of evaporative liquids as heat sinks, compares relative weights, power consumption and dissipation.

Flight Test Instrumentation Status

W. L. Howland, Lockheed Aircraft Corp.
While leading the developmental field, aircraft instrumentation needs charting for effective long-range research and development. This paper discusses present status, current problems, and future needs.
(Sponsored by Aircraft Activity)

9:30 a.m. **Sierra Room**

POWERPLANTS

Chairman—**T. R. Thoren,**
Thompson Products, Inc.
Secretary—**E. R. Schuberth,**
Lockheed Aircraft Corp.

Holding the Reins on 300,000 Horsepower

J. C. Wise, Marquardt Aircraft Co.
Powerplants can be so powerful as to make control a major problem. So it appears to be with the ramjets. The control industry still has problems in system environment, engine limits, and thrust.

Control Systems and Noise Problems for High-Speed Propellers

W. H. Clark and **Joern Schmey,** Curtiss-Wright Corp.
Trans- and supersonic flight create new problems of noise and control. Propeller characteristics affect both. Herein are presented approaches to stable control systems with fast response and the development of quiet-type propellers.

Have Teapot Tempests Come of Age?

H. J. Wood, AiResearch Manufacturing Co.
Recently developed gas turbines are creating new markets and applications without replacing older-type engines. Their evolution and future offer potentialities unrelated to gas turbine techniques of the past.
(Sponsored by Aircraft Powerplant Activity)

2:00 p.m. **Sierra Room**

ACCESSORIES

Chairman—**W. R. Ramsaur,**
AiResearch Manufacturing Co.
Secretary—**H. J. Wood,**
AiResearch Manufacturing Co.

Air Conditioning and Pressurizing a Fighter Airplane—Design Problems and Compromises

G. A. Lemke, Consolidated Vultee Aircraft Corp.
Engine bleed air pressurizes cockpits, cools cockpits and accessories, clears windshields, prevents icing. Big job is to minimize engine bleed requirements without complicating the plane, increasing its weight, or reducing its performance.

Small Turbines—The Heart of Modern Aircraft Accessory Power Systems

L. W. Biwer and **R. L. McManus,** General Electric Co.
As strategically important as the smaller wheel which turns the larger is the tiny turbine for aircraft accessory power. This paper outlines its future jobs in generating electrical power, driving pumps, and starting main engines.

Hydraulic Power Transmission for Accessory Drives

C. L. Sadler, Sundstrand Machine Tool Co.
Hydraulic transmissions become increasingly popular for transferring energy from aircraft powerplant to accessories. Actually, things aren't quite that simple, among them selecting the proper transmissions and integrating them with powerplants and airframes.
(Sponsored by Aircraft Activity)

2:00 p.m. **Los Angeles Room**

AIR TRANSPORT

Chairman—**W. W. Davies,**
United Airlines, Inc.
Secretary—**R. L. McBrien,**
United Airlines, Inc.

Trends in Gust Loads for Transport Airplane Operations

T. L. Coleman and **Roy Steiner,** National Advisory Committee for Aeronautics
In flying, altitude may skip the storms but not the gusts. Gust load measurements must be viewed by light of top-altitude consequences. Trends in design and operational factors are reviewed.

A Variable Fuel Policy for Medium Range Airline Operations

K. G. Wilkinson and **J. Vivian,** British European Airways
Conflicting objectives complicate the job of providing sufficient fuel for prolonged flight without overloading the plane. Rationality must enter into making the neat, nice, and dangerous distinction between enough and too much.

Helicopter Passenger Progress

C. M. Belinn, President, Los Angeles Airways, Inc.
Meet a new phrase and dimension, "total transportation." The author—admittedly leading with his chin—defines both with one word, helicopter, and then discusses burgeoning problems such as design, performance, navigation, improvements, and thinking.
(Sponsored by Air Transport Activity)

8:00 p.m. **Golden State Room**

Chairman—**Edgar Schmued,**
Northrop Aircraft, Inc.
Secretary—**R. P. Jackson,**
Northrop Aircraft, Inc.

Presentation of the
Manly Memorial Award
to R. E. Gorton and B. E. Miller
by **E. G. Haven,** Chairman
Manly Board of Award

Airplane Configurations for High-Speed Flight

C. L. Johnson, Lockheed Aircraft Corp.
Around Mach No. 2, flight speeds emphasize aircraft configurations, especially wing plan forms and tailless designs. Basic research on delta configurations has produced essential data, herein augmented by movies of flutter research on rockets.
(Sponsored by Air Transport, Aircraft, and Aircraft Powerplant Activities)

Saturday, Oct. 3

9:30 a.m. **Sierra Room**

COLD WEATHER OPERATION

Chairman—**W. C. Heath,**
Solar Aircraft Co.
Secretary—**W. W. Withee,**
Consolidated Vultee Aircraft Corp.

Airport Snow Removal and Ice Control

L. A. Johnson, Minneapolis-Saint Paul International Airport
Folks who think shovelling the home sidewalk is tough should learn about a wholesale operation—airport clearing. New equipment, methods, and procedures make delays because of snow not only frowned upon, but scorned as inferior technique.

Operating Aircraft in Cold Weather

Squadron Leader C. R. Thompson, RCAF Central Experimental and Proving Establishment Climatic Detachment
Arctic flying is routine, but operating aircraft from advanced northern bases without hangar and shop facilities is something else again. Five winters of observing 23 types of aircraft, including jets, have taught many useful lessons.
(Sponsored by Air Transport, Aircraft, and Aircraft Powerplant Activities)

Banquet and Grand Ball

7:30 p.m.
SATURDAY, OCT. 3, 1953
Pacific Ballroom
HOTEL STATLER, LOS ANGELES

Tickets $7.50 Each **Dress Optional**

Tables for ten reserved upon request, representatives limited to 30 tickets. Reservations by companies or company only to capacity of Ballroom. Reservations filled in order of receipt

(No cancellations accepted after September 30, 1953)



THE SAE COUNCIL is the governing body of the Society. Its members are outstanding among those "Men at Work" pictured from time to time in the pages of SAE Journal.

Here the 1953 SAE Council is shown in action at its June 11, 1953, meeting. Fifteen of its 22 members participated. Both Past-Presidents currently members of the SAE Council were at this meeting, as were President Robert Cass and Treasurer B. B. Bachman . . . also four of the six Councilors and seven of the 12 Vice-Presidents.

In addition, there were present (as there usually are) representatives of several administrative committees who were asked for reports at the particular meeting.

R. J. S. Pigott, President in 1948, attended to report a recent mission to Europe, where he conveyed official greetings from SAE to several foreign engineering societies.



Councilor R. Wayne Goodale (left) and Past-President D. P. Barnard



Councilor W. S. Cowell (left) and Vice-President G. C. Riegel representing Engineering Materials Activity



President Robert Cass (right), Secretary and General Manager John A. C. Warner (center), and Dora Cella, secretary to the General Manager



Past-President Dale Roeder



Councilor Charles A. Chayne (left), Councilor Earle S. MacPherson (center), and O. E. Kirchner, Vice-President representing Air Transport Activity



Vice-President E. G. Haven,
representing Aircraft Powerplant Activity



Vice-President N. R. Brownyer,
representing Truck and Bus Activity

J. H. Booth, Vice-President,
representing Passenger Car Activity





Vice-President F. A. Suess, representing Fuels and Lubricants Activity (left) and Past-President R. J. S. Pigott



Treasurer B. B. Bachman (left), and A. T. Colwell, Chairman of the Finance Committee





R. R. Faller, chairman, Student Committee (left), and A. O. Willey, vice-chairman of the Meetings Committee



Vice-President J. W. Pennington, representing Diesel Engine Activity (left) and E. K. Brown, member of the Sections Committee

National Meetings . . .

Meeting	Date	Hotel
	1953	
Tractor and Production Forum	Sept. 14-17	Hotel Schroeder, Milwaukee
Aeronautic Meeting, Aircraft Production Forum, and Aircraft Engineering Display	Sept. 29-Oct. 3	Hotel Statler, Los Angeles
International Production	Oct. 29-30	Royal York Hotel, Toronto
Transportation	Nov. 2-4	The Conrad Hilton, Chicago
Diesel Engine	Nov. 3-4	The Conrad Hilton, Chicago
Fuels and Lubricants	Nov. 4-6	The Conrad Hilton, Chicago
	1954	
Annual Meeting and Engineering Display	Jan. 11-15	The Sheraton-Cadillac Hotel and Hotel Statler, Detroit
Passenger Car, Body, and Materials	March 2-4	Hotel Statler, Detroit
Production Meeting and Forum	March 29-31	The Drake, Chicago
Aeronautic Meeting, Aeronautic Production Forum, and Aircraft Engineering Display	April 12-15	Hotel Statler, New York City
Summer	June 6-11	The Ambassador, Atlantic City, N. J.
West Coast	Aug. 16-18	Hotel Statler, Los Angeles
Tractor and Production Forum	Sept. 13-16	Hotel Schroeder, Milwaukee

Ancient Vehicles Dominate Far East Travel

• Hawaii Section
Richard C. Deemer, Field Editor

July 20—At the cocktail hour preceding the July dinner-meeting of the Hawaii Section, yachts participating in the Trans-Pacific Race proved the most popular subject. **Fred Hedemann,** Section Chairman, 30 members and guests met at Kewalo Inn just across from the yacht basin to hear **Herb Hagglund** report on "Automotive Transportation in the Far East."

Hagglund, who had just returned from a seven and one-half month trip around the world, told the group that Far Eastern transportation is dominated by ancient methods. For long hauls, water transportation, much the same as when Marco Polo went to China, is the most important. Railroads are second and motor vehicles are third in importance. Even for short hauls, motor vehicles rank third —behind hand-operated and animal-drawn vehicles. Development of good roads in the Philippines and Malaya have made those countries exceptions. There motor vehicles rank first.

A new highway similar to the Pennsylvania Turnpike, stretching 350 miles between Kobe and Tokyo and scheduled for completion in 1955, is expected to give automotive transportation a great boost in Japan. Currently railroads offer the only transportation method for such a distance because of the very poor roads. When the highway is completed, a cut in travel time to six hours is anticipated between these cities. Japanese influence on railroads has been important in Formosa also, as has the influence of the Dutch on railroads in Java.

A result of American influence is the network of good roads in the Philippines which the population can enjoy because of reasonable travel cost. Bus transportation is available for about a cent a mile. Buses and trucks are largely post-war and divided evenly between military and commercial types. Railroads are poor in the Philippines and animal-drawn vehicles are declining rapidly.

Poor roads and inefficiency of some other type of transportation have been most important in encouraging the use of motor vehicles in all Far Eastern countries.

Slides depicting some of the more interesting conveyances were shown to summarize the topic. Pictures ranged from barges on canals to English type double-deck buses used in some cities. Creating the most comment were slides showing the jeep (after-end slightly extended) carrying twelve or more passengers. This was used in the Philippines.

SAE Section Meetings

SEPTEMBER

Atlanta—Sept. 14

Dinner 7:00 p.m., meeting 8:00 p.m. Pistons, Pins, and Bearings—Norman Hertz, Thompson Products, Inc.

Buffalo—Sept. 17

Buffalo Trap and Field Club. Dinner 6:30 p.m., meeting 8:00 p.m. Plant tour through Cornell Aeronautical Laboratory. Speaker from Cornell.

Canadian—Sept. 28

Hamilton Golf & Country Club, Ancaster, Ont. Dinner 7:00 p.m., meeting 8:30 p.m. The Kitimat Development. A film presented by International Harvester Co.

Central Illinois—Sept. 28

Jefferson Hotel, Peoria, Ill. Dinner 6:30 p.m., meeting 8:00 p.m. Indianapolis Racing Car Design—R. T. Jackson, sales engineer, Perfect Circle Co.

Chicago—Sept. 11

Olympia Fields Country Club. Dinner 6:45 p.m. No technical meeting. Tenth annual playday and golf outing.

Detroit—Oct. 5

Rackham Educational Memorial Bldg. Dinner 6:30 p.m., meeting 8:00 p.m. The Corvette—Maurice Olley, director, research and development, Chevrolet Motor Division, GMC. Din-

Twin City's Governing Board Meets



Twin City Section's 1953-54 governing board paused during a recent meeting to have a group picture taken. Left to right are: S. Harold Beach, Donaldson Co., Inc., placement; Robert Rosenwald, Minneapolis-Honeywell Regulator Co., reception; Leslie W. Foster, Jr., Scott-Atwater Mfg. Co., Inc., secretary; B. J. Robertson, Minneapolis-Honeywell, past-chairman; Newman A. Hall, University of Minnesota, chairman; William E. Swenson, Minneapolis-Moline, Co., section delegate; D. L. Van Orman, Timkin Roller Bearing Co., membership; Donald Hornbeck, Ethyl Corp., meetings; Thomas Murphy, University of Minnesota, student chairman

ner Speaker—Arkus Duntov, Chevrolet Motor Division, GMC.

Indiana—Sept. 10

Marrott Hotel. Dinner 7:00 p.m., meeting 8:00 p.m. Topic to be announced. William B. Stout, Stout Research Laboratory, Phoenix, Ariz. Social Half Hour sponsored by Perfect Circle Co.

Mid-Continent—Sept. 11

Cushing, Okla. An Investigation of Preignition in Engines—W. E. Bettoney, assistant director, Petroleum Laboratories, E. I. duPont de Nemours & Co., Inc.

Northern California—Sept. 23

Engineer's Club. A panel discussion by name personnel from the racing field. A movie of a current 500-mile Indianapolis race and/or action shots of various racing highlights will probably also be included in the program.

St. Louis—Sept. 15

Meeting held in the afternoon. Plant tour of American Wine Co., formerly Cook's Champagne Co.

South Bend Division—Sept. 21

Hotel LaSalle, South Bend, Ind., Bronzewood Room. Dinner 6:45 p.m., meeting 8:00 p.m. Light Metals in the Car of the Future—J. H. Dunn, manager, Development Division, Aluminum Co. of America.

Southern California—Oct. 15

Auto Racing—Modern Style—Ray Crawford, owner-driver, Indianapolis Race Car. 1952 Mexican Road Race—color film. Sponsored by Passenger Car Activity.

Texas—Sept. 18

Dallas, Texas. Dinner 7:30 p.m., meeting 8:30 p.m. Engineering sales and service. Partners in Production—L. C. Mecklenburg, Southwest regional service manager, Ford Motor Co. A film, "American Road," will be shown.

Twin-City—Sept. 18

Curtis Hotel. Dinner 6:00 p.m., meeting 7:30 p.m. Engineering Frontiers—SAE President Robert Cass.

Good Cam Design Is Not an Accident

Excerpts from paper by **ALEXANDER GOLOFF** Caterpillar Tractor Co.

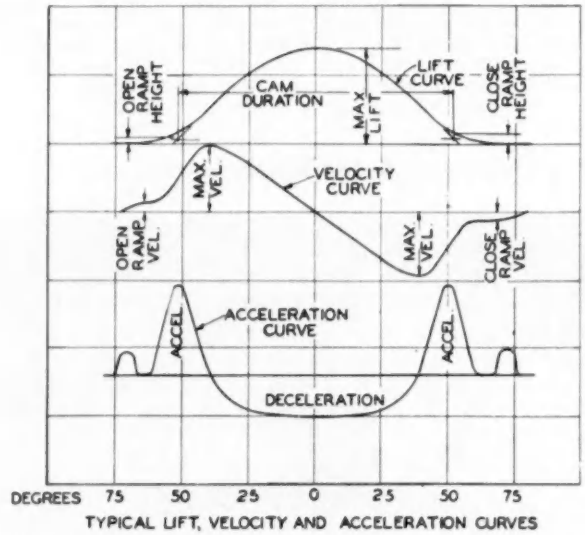
WHAT is good for one engine is not necessarily good for another, but there are a few fundamental principles which apply to all successful cam profiles.

We feel that the points of intersection between the tangents drawn through the points of maximum velocities and the horizontal line (where lash is just taken up) constitute a basic description of cam duration (see Fig. 1). It eliminates the variables of the ramp heights and the relatively short, but variable, positive acceleration regions.

The velocity curve (Fig. 1) describes best the ramp velocities and maximum velocities. Excessive opening ramp velocity can cause excessive train vibration and noise. Excessive closing velocity may cause seat or valve face wear and even valve head breakage. Insufficient ramp velocities can cause loss of power and valve or seat burning. Seating velocity of over 5 fps often leads to valve head breakage; between 2 and 5 fps can bring on dishing and wear; between ½ and 1 fps the operation is usually safe; below ½ fps is safe unless the valve burns from a combination of excessive ramp height and low ramp velocity. These figures are widely used as a guide, but past experience with a given engine or given type of engine is a much better criterion.

Maximum velocity should be as great as possible; it makes snappy valve action. However, enough smoothness of the acceleration curve must be preserved. It isn't wise to go after snappy action at the expense of valve train vibration. The acceleration curve controls the forces occuring in the valve train. It should be continuous; its maximum rate of change (the third derivative of the lift curve) should be reasonably low, and is governed by the tolerance of the engine toward rough valve action. Cams are designed to give power with good life and not to pamper the valve train.

The duration of the positive acceleration loop, which fixes the rate of acceleration change, should be great enough to accommodate at least 1½ and preferably two, cycles of vibration of the valve at top engine speed. Normally, this means at least 15 cam degrees. Maximum positive acceleration value is not too important, provided the valve gets there gradually enough. The rate of change is more important. The maximum value of the negative acceleration portion (deceleration) is governed by the minimum radius of



TYPICAL LIFT, VELOCITY AND ACCELERATION CURVES

Fig. 1—Showing lift, velocity, and acceleration curves of a typical cam profile. Note method of handling duration of the profile

curvature at the cam nose. The greater the deceleration, the smaller the nose radius and the higher the contact stresses at low engine speeds. At high speeds, the inertia of the valve effectively reduces the spring load on the tappet, and, therefore, the contact stress. If a flat follower is used and the cam bearing spacing is large, there is a possibility of edge loading on the cam profile. In this case, the computed contact stresses should be considerably below 100,000 psi. Spherically faced followers and barrel-shaped follower bodies help to reduce the evils of misalignment and so permit greater deceleration values.

A dwell can be produced by gradually reducing the deceleration in the region of maximum lift, thus, discontinuity in the acceleration curve is avoided. Apparently it is popular to introduce arbitrarily constant lift in the region of the dwell without consideration of the acceleration curve. This is not good practice. If a dwell makes the acceleration curve smooth, it is possible to produce snappier valve action without introducing objectionable vibration in the valve train. It is impossible actually to machine an abrupt dwell. More than likely, the acceleration curve at the dwell would be machined with a certain amount of grinding wheel vibration, which may, in turn, excite vibration of the valve. (Paper, "General Considerations in Cam Design" was presented at SAE Central Illinois Section, Peoria, Dec. 15, 1952. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers.)

New Techniques Aid Turbojet Research

Excerpts from paper by **WILLIAM A. FLEMING and H. DEAN WILSTED**
NACA Lewis Flight Propulsion Laboratory

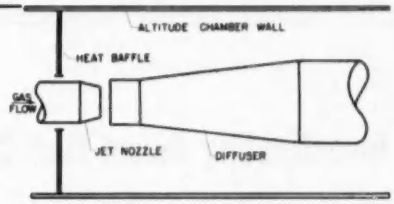


Fig. 1—Cross-section of typical exhaust jet diffuser installation

WHEN operating turbojet engines in altitude facilities, the maximum altitude or maximum Mach number limit of the facility is often met before that of the engine. To extend this limit for more complete evaluation of altitude performance, the Lewis Laboratory has developed two methods: one employs an exhaust diffuser, and the other, the choked exhaust nozzle technique.

In the first method, when the exhaust equipment has reached its minimum pressure limit, a further reduction in static pressure in the test chamber and consequently a further increase in simulated altitude or flight Mach number can be had by discharging the jet into a diffuser to recover some of the jet kinetic energy in the form of static pressure. A cross-section of the diffuser installation is shown in Fig. 1. Static pressure recovery occurs in two steps; sudden expansion and subsonic diffusion. Most of the pressure recovery occurs from the sudden expansion of the jet before it enters the exhaust duct, such as that obtained in an ejector. A small amount of additional pressure recovery can be obtained in the second step by utilizing a portion of the exhaust duct as a subsonic diffuser. With a properly designed exhaust diffuser, the jet diffusion will provide a static pressure at the subsonic diffuser inlet and consequently within the test chamber, which is considerably lower than the static pressure in the exhaust system.

Under some conditions it is possible to obtain a minimum test chamber static pressure approaching about one-half of the exhaust system pressure. Such gains represent significant extensions of the altitude facility limits. For example, if the maximum altitude obtainable at the exhausters is 45,000 ft, use of a 1.14 area ratio diffuser operating at its optimum condition would provide a test chamber pressure corresponding to an altitude of 56,000 ft.

A further extension of facility limits can be had by using the choked nozzle technique in conjunction with the exhaust jet diffuser. This technique is based on the principle that pressure waves travel at the speed of sound. Consequently, if the pressure ratio across the exhaust nozzle is supercritical, so that sonic velocity exists at the nozzle exit, further reductions in exhaust pressure cannot be transmitted upstream of the nozzle throat to the engine. If the engine inlet temperature and pressure are set to correspond to a particular flight condition with the exhaust pressure sufficiently low to maintain sonic velocity at the nozzle throat, the internal flow and performance of the engine will be the same as though the exhaust pres-

Continued on Page 109

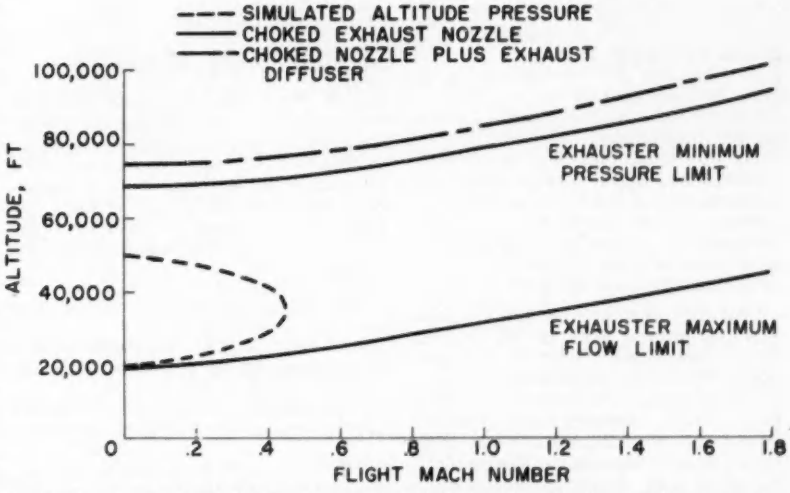


Fig. 2—Operating limits obtainable with combined choked nozzle and exhaust diffuser operation

TECHNICAL COMMITTEE *Progress*

Investigating Diesel Fuel Combustion Characteristics with Ignition Delay Bomb

INVESTIGATORS using the bomb technique for studying combustion characteristics of diesel fuels will find much useful information in two progress reports of the Diesel Bomb Advisory Group of the Diesel Fuels Division of CRC. They are:

1. "Combustion Characteristics—Ignition Delay Bomb (1948–1950)" (CRC No. 263) describes the apparatus and techniques used to obtain data. Experimental data are also given concerning the following investigations carried on by the Group:

(1) Investigation of heat transfer to injected fuel.
(2) Effect of fuel composition on measured ignition delay.
(3) Ignition lag sensitivity to cetane-number change.
(4) Ignition lag response to ignition quality improvers.

2. "Effect of Variation of Internal Atmosphere upon Evaporation and Combustion of Fuels in a Constant-Volume Bomb" (CRC No. 265) gives information about investigations of heat transfer and pressure phenomena in a constant-volume bomb.

The members of the Diesel Bomb Advisory Group are: E. W. Landen, Caterpillar Tractor Co.; A. J. Blackwood, Standard Oil Development Co.; H. F. Bryan, International Harvester Co.; J. R. MacGregor, Calif. Research Corp.; W. F. Ritcheske, Texas Co.; H. M. Smith, Bureau of Mines; L. L. Withrow, GM Research Laboratories Division; H. D. Young, Sinclair Refining Co.

CRC 263 contains 41 pages, including 17 illustrations and two tables. Its price is $1.50 to members, $3 to nonmembers. CRC 265 contains 24 pages, including 16 illustrations and one table. Its price is $1 to members, $2 to nonmembers. Both publications are available from SAE Special Publications Department.

Aero Materials Specs Reviewed by Industry

DRAFTS of nine revised and one new SAE Aeronautical Materials Specifications are currently being circulated to industry for comment and criticism by the SAE Aeronautical Materials Specifications Division. Copies of these specifications are available for review from the SAE Aeronautical Department.

The specifications under review are:

- AMS 3802B—Cloth, Airplane, Cotton Mercerized, 50 lb Breaking Strength
- AMS 3804A—Cloth, Airplane, Cotton Mercerized, 65 lb Breaking Strength
- AMS 3851A—Fire Resistant Properties for Aircraft Materials
- AMS 3852A—Flame Resistant Properties for Aircraft Materials
- AMS 3855A — Flame Resistance Treatment of Interior Fabrics
- AMS 4286—Aluminum Alloy Castings —Permanent Mold 5Si-1.2Cu-0.5Mg (356-T51) Stabilized Condition
- AMS 5521B—Steel Sheet and Strip, Corrosion and Heat Resistant 25Cr-20Ni (SAE 30310), (Deep Drawing and Spinning)
- AMS 5572B—Steel Tubing, Seamless, Corrosion and Heat Resistant 25Cr-20Ni (SAE 30310)
- AMS 5577A—Steel Tubing, Welded, Corrosion and Heat Resistant 25Cr-20Ni (SAE 30310)
- AMS 5651C—Steel, Corrosion and Heat Resistant, 25Cr-20Ni (SAE 30310)

How Variables Affect Engine Oxidation Tests

AN investigation made by a CRC group of the variables affecting reproducibility of results in multi-cylinder gasoline engine oxidation tests showed:

- A common test fuel and a more closely controlled test technique did not improve reproducibility in the series of tests conducted.
- No significant change in reproducibility exists between new engines catalytically conditioned in a specified manner and engines randomly conditioned and given six to fifteen L-4 tests prior to the cooperative tests.
- Standardization of the engine-fuel combination with a reference oil (to produce final bearing weight losses within a narrower range) does not improve reproducibility.
- The bearing-weight-loss versus test-time curve furnishes more information about the behavior of an oil than does the final weight loss alone. However, the induction period technique does not produce the expected improvement in reproducibility. In some cases, this technique is difficult to apply because of the nature of the curve produced by some types of oil.
- Reproducibility of deposit ratings is far superior to reproducibility of

bearing corrosion. (The investigation did not disclose the factors responsible for poor bearing corrosion reproducibility.)

This report, "Investigation of Variables in Multi-Cylinder Oxidation Tests," CRC-267, was prepared by a Panel of the CRC Oxidation Tests Group working on Motor Oil Projects of the Coordinating Lubricant and Equipment Research Committee. It is available from the SAE Special Publications Department. Price: $4.50 to members, $9 to nonmembers.

CRC Group Compares Road Rating Methods

THE CRC Road Rating Exchange Panel was charged in 1950 with carrying out a spring and fall program to (a) study the Standard Borderline and Modified Borderline Techniques to determine whether the two methods are interchangeable, and to (b) compare the reproducibility of these two techniques with the Modified Uniontown Technique.

Results of the 1950 test work show that:

1. Within reasonable limits, comparable results were obtained by the Standard Borderline and Modified Borderline Techniques throughout the speed range. At low engine speeds of about 1000 rpm, the Standard and Modified Borderline Techniques and the Modified Uniontown Technique produce similar ratings.

2. The magnitude of the average deviations was similar for both the spring and fall programs.

3. An average deviation of approximately 0.90 octane number occurred at 1000 rpm for both the Standard Borderline and Modified Borderline Techniques. The Modified Uniontown results showed a similar average deviation.

4. On the average, the spread between the maximum and minimum low-speed road ratings for all fuels and all methods was approximately 4 octane numbers. The maximum spread encountered on any one fuel and any one method was 10.6 octane numbers.

5. Average fuel ratings varied among makes of cars. These data indicate maximum rating differences of 2 octane numbers at low speeds and 5 octane numbers at high speeds.

The Road Rating Exchange Panel is part of the Road Test Group Working on Detonation Projects of the CFR Motor Fuels Division.

The report "Analysis of 1950 Road Rating Exchange Data," CRC-264, contains 31 pages including seven figures and 16 tables. It is available from the SAE Special Publications Department. Price: $1.00 to members, $2.00 to nonmembers.

SAE Undertakes Study Of Residual Stresses

THE SAE Iron & Steel Technical Committee recently organized a new division to deal with residual stresses. Development of this group grows out of a fairly universal thirst for knowledge on the magnitude of residual stresses and their effect on service performance of fabricated metallic parts.

Metallurgists and engineers do know that processing—such as heat treating, machining, shot peening, and forging—impart residual stresses to a part. Some of these residual stresses enhance the part's fatigue life and resistance to service stresses; others are detrimental. Right now there is no unanimity among specialists as to how to measure residual stress.

A steering committee, headed by E. S. Rowland, Timken Roller Bearing Co., is now selecting the personnel for the new ISTC division. This group also is establishing the scope of the division and determining a detailed working program.

This undertaking has met with enthusiastic response from men in industry, colleges and universities, and research laboratories. Residual stress seems to be a problem of growing concern. A number of engineers have indicated an eagerness to participate and help in this cooperative program.

Study Need for New Injection-Pump Mounting Standard



TO consider standardizing mountings for diesel distributor-type fuel injection pumps these men met recently at SAE headquarters. The occasion was a meeting of the Fuel Injection Mountings Subcommittee of the SAE Engine Committee and others interested in the mountings.

Seated are J. F. Greathouse of Mack (left) and R. L. Shallenberg of International Harvester. Standing are (left to right) E. F. Grimmeisen of Hartford Machine Screw, W. J. Gewinner of American Bosch, C. V. Brack of Scintilla, K. M. Cloud of Continental Motors, and A. A. Court of Buda.

Shallenberg is chairman of the subcommittee. Members not shown are N. Fodor of Diesel Engineering & Mfg., L. J. Garday of Scintilla, C. N. Guerasimoff of Buda, Wesley Klatt of Waukesha, C. F. Pervier of Baldwin-Lima-Hamilton, and O. D. Treiber of Hercules Motors.

The subcommittee has already worked out standards for mountings for single-plunger and multiple-plunger injection pumps, and they appear in SAE Handbook. Now the subcommittee is contemplating developing a recommendation on dimensions for mountings for the newer, distributor-type pumps as a guide for future design.

About



L. C. GOAD has been elected president of the new Boys Committee of Detroit, an organization of community leaders which will aid boy's work mainly by a yearly Boys Bowl football game and a Boys Day program. Goad, executive vice-president and a director of GMC, Detroit, is a past vice-president of production of the SAE.



JOHN G. WOOD, a past SAE vice-president of passenger car activity, is now a consultant and technical adviser for The New York Air Brake Co., New York. He will organize, coordinate and direct the over-all engineering activities of the company. Wood retired a few years ago as chief engineer of the Chevrolet Division, GMC.



RAY H. BRUNDIGE has become vice-president of Columbia Terminals Co., St. Louis. He was previously president of Columbia Transportation Service, Inc., Cincinnati, a subsidiary of Columbia Terminals.



HERMAN PLEW has retired as general-manager of the Herman Body Co., St. Louis, which was merged last year with Jerry O'Mahoney Co., Inc., Elizabeth, N. J. Founder of the company in 1921, Plew guided it from local to national leadership.



HERMAN L. WECKLER, who retired from Chrysler Corp., Detroit, last April, has been elected vice-president of operations for Clevite Corp. At Chrysler, he had been vice-president and general-manager.



LEONARD RAYMOND has moved to the New York office of Socony-Vacuum Oil Co. as assistant chief engineer of the Automotive Division of the Lubricating Department. For some years past, he has been assistant supervisor of the Research and Development Department of the company's Socony-Vacuum Laboratories Division. Raymond has been active in SAE administrative and technical committee work. He is currently Section Committee representative on the SAE Meetings Committee and is a member of the Fuels & Lubricants Activity Committee. In 1949–50, he was chairman of the SAE Philadelphia Section.

FRANK E. PHILLIPS, senior vice-president of Gemmer Mfg. Co., Detroit, has retired after 45 years with the Company. A member of the Gemmer board of directors for the last 20 years, he will devote his time to private interests.

ROBERT J. LUNN, supervising engineer of research and development for Donaldson Co., Inc., St. Paul, Minn. will be in charge of Donaldson's engineering and research laboratory to be built in Fridley.

RICHARD A. SPRAKER is in the Petroleum Chemicals Division of E. I. du Pont de Nemours & Co., Inc., Wilmington, Del., as sales representative. Spraker was development engineer for du Pont in the Petroleum Laboratory, Deepwater, N. J.

EDWARD J. GUTHMANN is a service representative for Caterpillar Tractor Co., Peoria. Guthmann was formerly a trainee at Caterpillar.

FRANK J. PRYATEL, previously chief metallurgist for Oliver Corp.'s South Bend Plants, is now methods and standards supervisor for Oliver in Euclid, Ohio.

J. HOMER HAROLD OVERHOLSER has become assistant general manager of the Pacific Division, Bendix Aviation Corp., in North Hollywood, Calif. He was formerly executive vice-president of Hydro-Aire, Inc., Burbank, Calif.

ROBERT V. WAGNER is with Le Roi Co., Milwaukee, as product designer. Wagner previously held the same position in the Centaur Division of Le Roi, Greenwich, Ohio.

WILLIAM E. ACHOR is chief engineer for Thompson Products, Inc., Bell, Calif. Previously he was quality coordinator for Thompson in the Valve Division, Cleveland.

Members



GEORGE W. BORG, formerly chairman of the supervisory board, Borg & Beck Division, Borg-Warner Corp., Chicago, will now serve as chairman of the executive committee.



D. E. GAMBLE, previously president of the Borg & Beck Division of Borg-Warner, has been named chairman of the supervisory board.

A. W. ROSE has been appointed Pacific Coast Representative of Borg-Warner Corp., Chicago, and has resigned as vice-president and assistant general-manager of the corporation's Warner Gear Division.

JOHN RIZZARDI, formerly with the AC Spark Plug Division, GMC, Flint, Mich., is now in the engine division of Ford Motor Co., Chicago.

LESLIE T. VILAND, previously a project engineer "A" in the engineering laboratory of Ford Motor Co., is now a service engineer "A" in the technical standards section, service department, Ford Motor Co.

CHARLES LEO TEETER, formerly an aeronautical research scientist for the National Advisory Committee for Aeronautics, Cleveland, is doing graduate work at the University of Minnesota, Minneapolis.

RAYMOND L. MORELAND, who was development engineer for Ward Products Corp., Division, Gabriel Co., Ashtabula, Ohio, is now sales engineer for Sargent Enginairing Co., Cleveland.

FRANCIS JAMES SEHN, formerly sales engineer for Clearing Machine Corp., Detroit, is a vice-president and sales manager for Sahlin Engineering Co., Birmingham, Mich.

DON A. LAWLESS has joined Sam Tour & Co., Inc., New York, as assistant director of the metallurgical department. He was previously employed by Kaiser Aluminum and Chemical Corp., Spokane, Wash., as technical advisor to the development and engineering department.

E. C. VALLIN, field engineer, Lord Mfg. Co., Detroit office, has announced the new location at 311 Curtis Bldg., 2842 West Grand Blvd.



A. J. McALLISTER has retired from the presidency of Detroit Gear Division, Borg-Warner Corp., to give full attention to personal business interests.



ABRAM vanderZEE, vice-president of Chrysler Corp., Detroit, is serving on the Inter-Industry Highway Safety Committee as a representative of the automobile manufacturers.



MARC RESEK, formerly vice-president of engineering for Perfection Stove Co., Cleveland, Ohio, has been named vice-president in charge of all research. This appointment is part of a change at Perfection aimed at streamlining operations.



DAVID KARL WIRTH has become president and chairman of the board of Michigan Material Handling Corp., Detroit. He was previously vice-president of Material Handling Sales Corp., Milwaukee.



ANDREW L. POMEROY has been appointed manager of an Atomic Energy Commission plant to be constructed in Fulton County, Illinois. To be operated by Thompson Products, Inc.; the plant will be known as the Spoon River operation and will be an explosives processing and assembly installation. Pomeroy has been the company's associate director of central staff research and development. He has served as meetings vice chairman of the SAE Aircraft Powerplant Activity Committee and has been active on administrative committees of the Society.



WILLIAM A. BLUME, vice-president of sales for Gemmer Mfg. Co., Detroit, has been elected a director of Gemmer. Blume was appointed vice-president last May and was previously vice-president of the Thermoid Co., Trenton, N. J.



T. G. PRESTON, formerly general sales manager for Prenco Progress & Engineering Corp., Ltd., Toronto, Ont., Canada, has been named vice-president and general-manager of Stratoflex of Canada, Inc., Toronto, a new organization.



FRED E. AMON, JR., previously aircraft sales-manager of The Parker Appliance Co., Cleveland, has been named vice-president in charge of sales for Parker Aircraft Co., Los Angeles, a subsidiary of Parker Appliance.

Eaton Mfg. Co. Names Three



Archangeli



Stearns



Harrison

M. D. ARCHANGELI, J. R. STEARNS and **J. R. HARRISON,** three SAE members who have been promoted at Eaton Mfg. Co., Cleveland. Archangeli, formerly sales-manager of the Valve and Saginaw Divisions, is now general sales-manager of these divisions. Stearns, previously assistant sales-manager, is sales-manager of the Valve Division and Harrison is sales-manager of the Saginaw Division.

NORMAN LEVINE, formerly with Kaiser-Frazer Corp., Willow Run, Mich., has joined Ford Motor Co.'s Tractor Division, Highland Park, Mich., as quality control engineer.

GEORGE J. NEWMAN is now assistant-manager, equipment sales, for Purolator Products, Inc., Rahway, N. J. He was previously sales engineer for Purolator.

CECIL H. CRAWFORD, has become owner and manager of the Cecil H. Crawford Co., Waukegan, Ill. Crawford was quality control manager for David Bradley Mfg. Works, Bradley, Ill.

JOHN A. RIZZARDI is with Ford Motor Co., Aircraft Engine Division, Chicago, as a project engineer. He was formerly research and experimental engineer for AC Spark Plug Division, GMC, Flint, Mich.

WILLIAM J. ATWELL is with the U. S. Asbestos Division, Raybestos-Manhattan, Inc., Manheim, Pa., as a development engineer. Atwell was project engineer for Gulf Research & Development Co., Pittsburgh, Pa.

HERMINIO LORENZ KERR, previously chief electrical engineer for Sudeletro S. A., Sao Paulo, Brazil, is now with the Paulo Afonso Hydroelectirc Project, Brazil, as electrical engineer in charge of substations.

STANLEY GOLDSTEIN, previously sales engineer for Stewart-Warner Corp., South Wind Division, Indianapolis, Indiana, is now project engineer for the same company.

EARLE F. COX, who was formerly chief engineer for Harris Mfg. Co., Stockton, Calif., has joined Booz, Allen and Hamilton, Chicago, as a consultant. His first assignment will be in Genoa, Italy.

ROBERT S. CLUFF, previously vendor coordinating engineer for the Lincoln-Mercury Division, Ford Motor Co., Detroit, is now with Mayes Tool Co., Detroit, as chief-engineer.

ROLAND J. WOLFE, previously co-pilot for Hawaiian Airlines, Honolulu, is now co-pilot for Mohawk Airlines, Ithaca, New York.

GARY G. SINTON, formerly aerodynamic engineer for Glenn L. Martin Co., Baltimore, is with Jacobs Aircraft Engine Co., Pottstown, Pa., as aerodynamic engineer.

PAUL J. PAPANEK has been appointed manager for the Eastern District for Marquardt Aircraft Co., Van Nuys, Calif. He was previously Washington, D. C. manager for Jack & Heintz, Cleveland.

GUY L. STEVENS has been elected a member of Automotive Affiliated Representatives. Stevens is general manager of Groove-Rite Tool Co., Farmington, Mich.



G. E. Burks

Caterpillar Engineering Promotions



John E. Jass

Further decentralization of Caterpillar engineering functions with corresponding new duties for certain Engineering Department personnel is announced by executive vice-president, **H. S. EBERHARD.** These changes became effective August 1.

To co-ordinate the program of all engineering groups serving the various plants and divisions of the Company will be the responsibility of **G. E. BURKS,** who becomes director of engineering.

JOHN E. JASS succeeds Burks as chief-engineer of the Peoria plant. **PAUL B. BENNER** becomes assistant chief-engineer at the Peoria plant with supervision over design of motor graders and wheel tractors. **CARL L. KEPNER** becomes assistant chief-engineer with supervision of earthmoving equipment now manufactured at the Joliet plant.

Burks has been chief-engineer at Peoria since 1942. He is currently a member of the SAE Technical Board. Jass has been assistant chief-engineer at Caterpillar since 1950. Benner has been supervising-engineer of Caterpillar's rubber-tired earthmovers, and Kepner has been general supervisor of tractor attachments design.



Paul B. Benner



Carl L. Kepner

CAPT. JOHN C. WERTZ, who has just returned from Japan and a combat tour as navigator on B-29's, is at Wright-Patterson Air Force Base, Ohio, as staff-assistant for development of USAF Training Equipment.

ADAM EBINGER, chief engineer of the St. Louis Public Service Co., has been employed by New York City's Transit Authority to examine the city's surface transportation lines for practicable cuts in maintenance costs.



Named by Fairchild



Gregory



Conlon

ALFRED T. GREGORY and **EMERSON W. CONLON** have been appointed to new positions as part of an expanded engineering program in the Engine Division, Fairchild Engine and Airplane Corp., Farmingdale, N. Y. Gregory, chief engineer at Fairchild for 16 years, will head research and advanced engineering. He is a past vice-president of SAE for aircraft powerplants. Conlon, who will head development engineering, has resigned as chairman of aeronautical engineering, University of Michigan.

FRED A. ROBBINS has been appointed chief-engineer of the Piston Ring Department, Koppers Co., Inc., Baltimore. Robbins was representative for diesel-engine activity in 1952.



J. R. MacGREGOR has been appointed to the new post of research coordinator of petroleum products for California Research Corp., San Francisco. He is a past vice-president of the SAE for Fuels and Lubricants.





J. C. KNAPP, 1952–53 vice-chairman of the Oregon Section, has been promoted to assistant to the regional manager, The White Motor Co., with headquarters at San Francisco. Knapp has been with White 33 years and was previously manager of the Portland branch.



WILLIAM TAUSS has been appointed chief field engineer of the Brake Drum Division, Copperweld Steel Co., Glassport, Pa. He was previously chief field engineer of the Grey Rock Division, Raybestos-Manhattan, Inc., Manheim, Pa.



J. W. DUHN has been appointed assistant chief-engineer in the electrical section of Chrysler Corp.'s Engineering Division, Detroit. **JOHN T. MOREN**, previously project engineer for Chrysler, has succeeded Duhn as supervisor of the heating and air conditioning laboratory.



W. E. LYON has been promoted to director of tire engineering and development, Firestone Tire & Rubber Co., Akron. Lyon was manager of the development department.



J. J. ROBSON, formerly manager of tire engineering, will take on additional duties as manager of tire engineering and development, Firestone Tire & Rubber Co., Akron.



R. TOM SAWYER, manager of research for American Locomotive Co., has been transferred from the company's New York City offices to the Schenectady plant.

LT.-COL. SIDNEY G. HARRIS, USAF, who was director of materiel, Wolters Air Force Base, Mineral Wells, Texas, is now a student, logistics staff officers course, Air Command and Staff School, Air University, Maxwell Air Force Base, Alabama. He is a past chairman of the SAE Metropolitan Section.

T. H. McCONNELL, JR., will serve as general-manager of Haartz-Mason, Inc.'s new Mechanical Products Division in Watertown, Mass. McConnell was formerly supervisor of sales for Vulcan Rubber Products, Inc., New York.

A. D. SLATKIN, formerly superintendent at Ford Motor Co.'s Aircraft Plant, Kansas City, Mo., has been named manufacturing-engineering manager, Trim Plant, Ford Division of Ford Motor Co. in Highland Park, Mich. He has resigned as 1953–54 vice-chairman of SAE's Kansas City Section.

ROBERT K. WATTSON, JR., has joined Cessna Aircraft Co. in Wichita, Kansas, as project engineer. Wattson was associate-professor of aeronautical engineering, North Dakota State College, Fargo, N. D.

FREDERICK HYATT, JR., formerly sales engineer in the Omaha office of Westinghouse Air Brake Co., has joined Turbine Equipment Co. of New England, Boston, as sales engineer in charge of the Springfield office.

RICHARD de HART WILLIAMS is now president of the Harrison Mfg. Co., Burbank, Calif. Williams was formerly project engineer for Hughes Aircraft Co., Culver City, Calif.

RICHARD V. KLIKUNAS, formerly design engineer, Allstates Co., Albany, N. Y., has joined Rensselaer Valve Co., Troy, N. Y., as director of engineering.

GLENN F. KLOIBER has joined the W. L. Morrison Co. of Lake Forest, Ill. He was previously with the Waukesha Motor Co., Railway Division, Waukesha, Wisconsin.

CHARLES H. YOUNG, JR., has become branch engineer of the new Bendix-Westinghouse Automotive Air Brake Co.'s plant in Oklahoma City, Okla. He was formerly sales engineer for Bendix-Westinghouse in Elyria, Ohio.

WILLIAM H. BICKERSTAFF, who was detail project engineer, Pontiac Motor Division, GMC, has joined Howell Electric Motors Co., Howell, Mich.

LLOYD C. STARKWEATHER has written that The Cousins Tractor Co., Bakersfield, Calif., is now Davies Machinery Co. Starkweather is service manager for Davies.

JAMES J. WILDER is now with Flight Refueling, Inc., Danbury, Conn., as chief of quality control. Wilder was previously assistant chief, quality analysis office, Wright-Patterson Air Force Base, Ohio.

JAMES L. RYAN is now general-manager of Bucks Rental Co., Pottstown, Pa. He was formerly associated with A. E. Friedgen, Inc., New York.

JAMES L. McINERNEY has been named board chairman, McInerney Spring and Wire Co., Grand Rapids, Mich. **JAMES M. McINERNEY,** the latter's son, has been elected to his father's former position as president, and **WILLIAM K. McINERNEY,** another son, is now executive vice-president. All are directors as well.

A. C. COX, formerly engineer for Bastian-Morley Co., La Porte, Indiana, has joined Tonn & Blank, Inc., General Contractors, Michigan City, Indiana, as an engineer.

CHARLES H. YOUNG, JR., has become branch engineer for the new Bendix-Westinghouse Automotive Air Brake Co. plant in Oklahoma City, Oklahoma. He was previously sales-engineer for Bendix-Westinghouse, Elyria, Ohio.

M. T. MOLER has been named sales manager of The United Specialties Co.'s Chicago plant. Moler was formerly advertising manager for United in Chicago.

JOHN W. GRAHAM, formerly manager of foreign sales for Union Oil Co. of Calif., is now manager of the Central and South American territory for Union Oil, stationed in the Canal Zone.

JAMES A. BECKETT, previously chemist for Norfolk & Western Railway Co., Roanoke, Va., is now research engineer with Fram Corp., East Providence, R. I.

ROBERT LEWIS BALLARD is now senior project engineer for Harrison Radiator Division, General Motors Corp., Lockport, N. Y. He was previously electrical engineer in GMC's styling section, Detroit.

WILLIAM MULOCK BROWN, formerly design engineer for Willys Motors Corp., Toledo, is now design engineer with the Bendix Products Division, Bendix Aviation Corp., South Bend, Indiana.

WILLIAM H. TAYLOR, previously general sales manager for Tinnerman Products, Inc., in Cleveland, is now director of purchases for Packard Motor Car Co., Detroit.

EVERETT M. SANDAHL is now with International Harvester Co., Chicago, as a design engineer. Before he joined International Harvester, Sandahl was a graduate student at Iowa State College.

Cadillac Appointments



Tell



Adams



Morphew

WILLIAM J. TELL, DANIEL M. ADAMS, and **CLARENCE E. MORPHEW** have been appointed to high positions in the Engineering Division of Cadillac Motor Car Division, GMC, Detroit.
Tell, formerly staff engineer in charge of body and sheet metal design, has been promoted to the new post of staff engineer in charge of future body and sheet metal styling.
Adams, previously assistant-staff engineer in charge of sheet metal, has succeeded Tell as staff engineer, body and sheet metal, and Morphew, who was a staff engineer at Cadillac's Cleveland Tank Plant, has filled Adams' former position.



C. W. OHLY has been made assistant general-manager of the Michigan plant of Thompson Products, Inc., Cleveland. He was formerly manager of the Special Products Division of Thompson.



HORACE B. VAN DORN has been appointed technical development manager of Fafnir Bearing Co., New Britain, Conn. He will also continue in his position as superintendent of the experimental and methods development department.



RALPH E. WILLIAMS has been appointed assistant works-manager for The De Laval Separator Co., Poughkeepsie, N. Y. He was formerly associated with National Pneumatic Co., New York, as director of purchases.



FRED L. HALL has been appointed sales-director of national accounts for Associated Transport, Inc., New York. Hall was sales manager of Brown Equipment and Mfg. Co., New York.

SAE Father and Son



ROBERT A. PADGETT (left) and **JOSEPH E. PADGETT** (right) talk over mutual interests at the senior Padgett's home in La Jolla, Calif. Robert is production engineer at Solar Aircraft in San Diego, where his father was a vice-president when he "retired" a few years ago. Right now, Padgett senior, an SAE past vice-president for Production Activity and for many years a vice-president of Spicer, is president of the San Diego City Planning Commission and on the board of directors of the San Diego County Planning Congress . . . and in his spare time, he's writing a book entitled, "The Logic of Democracy."

JERRY E. CARDILLO is a technical analyst in the technical service department of Ford Motor Co., Dearborn, Mich. He was formerly assistant chief-engineer in the landing gear division of Willys Overland Motors, Inc., Toledo.

JAMES BELLAMY MACKANESS is now with Highland Laboratories, Inc., Holliston, Mass. He was previously with Morris Motors, Oxford, England, as an assistant experimental engineer.

V. C. BARTH has been named assistant engineer of tests for the Chicago & North Western Railway System. He was formerly chief chemist of the system.

DONALD H. FIDLER, previously a lieutenant in the U. S. Air Force, is now in the Patent Office, Department of Commerce, Washington, D. C., as a patent examiner.

KEITH E. COXE has joined Goodyear Aircraft Corp. as a senior designer in the Arizona Division at Phoenix.

FRED A. IRWIN is fleet supervisor for Johnson Trucking Co., Columbus, Ohio. Irwin was previously with Hancock Trucking, Inc., Evansville, Indiana.

LYLE DAVIS, formerly sales manager of lubricants, Central Division, Macmillan Petroleum Corp., Los Angeles, is now sales manager of national accounts for Macmillan.

GLEN R. WALTERS is with the Petroleum Chemicals Division, E. I. du Pont de Nemours & Co., Inc., Delaware, as a sales-service engineer trainee. Walters was a junior engineer "A" for Boeing Airplane Co., Seattle.

CARL KLATTE, formerly fleet superintendent for Telford & Lux Drayage Co., Norwood, Ohio, is now service manager at Lake GMC Truck Sales, Inc., Cincinnati.

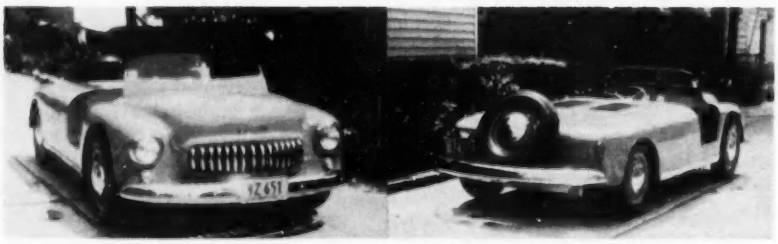
JOHN L. COLLYER has been named chairman of the board of trustees of Cornell University. **LEROY R. GRUMMAN** has been elected alumni trustee of Cornell for a five-year term to succeed **J. CARLTON WARD, JR.**

BURNHAM ADAMS has resigned as sales manager of AiResearch Mfg. Co., Los Angeles. Adams, formerly with Lear, Inc. as vice-president in charge of Western operations, has not announced his future plans.

ROBERT LEROY STANLEY is with the Diesel Engine Manufacturers Association, Chicago, as educational director. He was previously associate-professor of engineering-research at Penn State College and served the DEMA on a part-time basis as consultant.

ROBERT J. NEUBACHER is with Continental Motors Corp., Getty Street Plant, Muskegon, Mich., as engineer. Formerly he was assistant ring engineer for Burd Piston Ring Co., Rockford, Ill.

RUSSELL A. GRAHAM and **JOHN P. BUCK** are two of five new directors added to the board of Maremont Automotive Products, Inc., Chicago. Graham was previously an executive engineer for Maremont and Buck was a plant manager.



JOHN J. PALERMO has written that he foresees small-scale production of the "Centaur" (above) with a glass fiber body. A custom-built, two-place, rear-engined sports car, it is intended for pleasure driving or possible four-cylinder class road-competition racing.

Begun three years ago by Palermo and Brewer, mechanical engineers, the car won second prize in the custom-car class at the World Motor Sports Show in New York last March. It has a 92-in. wheelbase, 159-in. overall length and 7-in. ground clearance.

Obituaries

HAROLD W. SLAUSON

Harold W. Slauson, 70, died instantly from injuries suffered in a car accident, July 22.

An SAE member for over 40 years, he was chairman of the Metropolitan Section of SAE in 1921 and a member of the SAE Sections Committee, 1923. At the time of his death, Slauson was a member of the Syracuse Section and also held membership in the American Society of Mechanical Engineers.

A native of New York, Slauson was born in Middletown, Orange County. He attended Middletown High School and received an M.E. degree from Cornell University in 1907. At Cornell he specialized in automobile construction.

After graduation, he was an associate of the Technical Press Bureau and later associate editor of Recreation Magazine, both in New York City. In 1909 he went back to the Technical Press as manager where he prepared technical articles for automotive trade papers.

He joined Leslie's Weekly, Fifth Avenue, in 1912 and became editor of Leslie's Motor Review in 1915. Manager of the engineering service department, Kelly-Springfield Tire Co., New York, in 1920, he was in charge of technical assistance given to truck and car users as well as the sales and advertising departments.

He is survived by his wife, Mrs. Helen Slauson; three daughters, Mrs. Herbert Hanson, Chambersburg, Pa., Mrs. Henry B. Williams, Maumee, Ohio, Mrs. Edward Benedict, Mamaroneck, N. Y.; and a brother Col. Kinsley Slauson, Fort Lauderdale, Fla.

RALPH E. MORRISON

Ralph E. Morrison died July 15, five days before his sixty-eighth birthday and after a long illness. He was a partner and sales manager of Kelly Auto Body Co., Cincinnati.

A member of many organizations, Morrison was 1947–48 chairman of the SAE Cincinnati Section. His other memberships included the Cincinnati Club, the Scottish Rite and Chief Box 13 Associates. Since World War II, he was a Red Cross and first-aid instructor. At one time he was also in the Ohio National Guard.

An active church-worker, Morrison was an elder and clerk for Knox Presbyterian Church, Cincinnati, past-president of Presbyterian Men, active in the National Conference of Christians and Jews and a thirty-second degree Mason.

He was born in Cincinnati and attended Walnut High School and the University of Cincinnati. He was a C.P.A. by a state examination in Kentucky.

From 1917–1925 he was vice-president in charge of production and sales for United States Motor Truck Co. In 1925 he joined Kelly Body Co. as manager in charge of production and design. Then he was with the Highland Body Mfg. Co. as vice-president, but in '35 rejoined Kelly as a partner.

Surviving are his widow, Mrs. Elizabeth Hathaway Morrison; two daughters, Mrs. Elizabeth Kipp and Mrs. Marjorie Wyckoff; two sons, M. Edwin and Robert E.

RUSSELL SEVERANCE SPRINGER

Russell Severance Springer, 72, died July 17. Springer had been retired for many years from The Holt Mfg. Co., Stockton, Calif.

Named a vice-president of Holt in 1914, he was previsouly secretary and general works manager. He joined the company in 1906 as an assistant superintendent.

Before joining Holt, he had worked for Pacific States Telephone & Telegraph Co., San Francisco, as a draftsman, and for Houser and Haines Mfg. Co., Stockton, as a foreman of the machine shop.

A member of the American Society of Mechanical Engineers as well as SAE, Springer was a graduate of the University of California where he received his B.S. degree.

EARL WALLACE WINANS

Earl Wallace Winans, 72, died July 4 in his summer home at Wheatley, Ont. He had recently retired as chief-engineer of Federal Motor Truck Division, Fawick Corp.

Winans, with Federal for 38 years, was a chief-engineer for R. C. Hupp Corp. and had been employed by Electric Vehicle Co., Hartford, Conn., Ohio Brass Co., Mansfield, Ohio, and Regal Motor Car Co., Detroit. At one time he was president of Dominion Motor Co. in Toronto.

Born in Columbus, Indiana, Winans earned his BS in mechanical engineering from Purdue in 1902. He then entered the automotive field immediately. He was a member of the SAE for 35 years.

Winans is survived by his wife, daughter and brother.

HERMAN MATHIS

Herman Mathis, automotive engineer for Gulf Oil Corp.'s Philadelphia Division, died July 21. Mathis had celebrated his sixty-fifth birthday earlier in July and had completed almost forty years with Gulf.

A native of New Jersey, Mathis was born in Tabernacle. He was a student of the public schools and did extensive home study on automotive engineering.

While in the Philadelphia sales department, in 1923, he was appointed SAE representative from Gulf, an affiliate member. In 1948, when affiliate memberships were abolished, he came into the Society as associate-member.

He became a lubrication engineer for Gulf in 1931. Later, as automotive engineer, his specialty was diagnoses of engine ailments. He investigated all types of vehicle complaints and gave general advice on matters pertaining to maintenance, lubrication and operation of truck, tractor, marine, passenger-car and aircraft engines.

CARL O. WEST

Carl O. West, transportation superintendent at the United States Naval Ordnance Test Station, Inyokern, China Lake, Calif., died February 16. West was 57.

A civilian employee of the Navy since 1950, he was in charge of the Transportation Division, which included the operation and maintenance of 1400 units of automotive equipment.

Prior to his work with the Navy, West was self-employed as a consulting electrical engineer in Pasadena, Calif., doing design and layout of controls and circuits for lighting and power in industrial plants and commercial buildings.

He was with the Department of Water and Power, Los Angeles, for over twenty-three years where he rose from sub-station operator to engineer in charge of general plant division. Between 1921 and 1944 he held various positions with the Department as engineer in charge of records and research, assistant to engineer of operation, and executive assistant to the chief electrical engineer and general manager.

GEORGE A. SPOON

George A. Spoon, vice-president of sales and engineering for Muskegon Motor Specialties Co., Muskegon, Mich., died suddenly July 17 while on a business trip in Milwaukee. He was 58.

An authority in the design and manufacture of camshafts, he began working for the Muskegon company in 1912 as a machine opeartor. Later he became inspector of camshafts and

Obituaries

(Continued)

then draftsman, designing machines and tools.

Prior to his assuming the vice-presidency of sales and engineering in 1951, he was chief engineer and sales manager.

Before that he held various positions as assistant manager in charge of shop and engineering, engineer in charge of tool and machine design and tool maker, making master cams for camshafts.

GUSTAVE JOASSART

Gustave Joassart, a vice-president of the Fabrique Nationale d'Arms de Guerra, Herstal-Lez-Liege, Belgium, died June 4. He was 73.

Appointed representative to SAE in 1930 by Fabrique Nationale, an affiliate member of the Society, he succeeded Alexandre Galopin.

At that time he was general-manager for Fabrique, producer of bicycles, trucks and motorcycles as well as tools, arms and ammunitions. General-manager since 1923, he was formerly general-secretary.

Jossart was born in Liege where he attended the University from 1898–1903 and received his Doctor of Laws degree.

CHARLES O. BIRD

Charles O. Bird, 44, senior engineer for the Saratoga County Highway Department, Saratoga Springs, N. Y., died June 24.

Bird, a native of New York, went to work as an assistant supervisor for the Imperial Paper & Color Co., Glens Falls, N. Y., after graduating from Syracuse University in 1931. He became an engineer in 1937 for Good Roads Machinery Co., Kennett Square, Pa., and then worked with the same title for The Autocar Co., Ardmore, Pa., and The Brooks Equipment & Mfg. Co., Knoxville, Tenn.

Formerly he was with the Dept. of Interior, U. S. Geologic Survey, Wash., D. C., and from 1935–1937 the Saratoga County Highway Dept., Saratoga Springs, where he specialized in equipment performance as regards snow removal.

R. BERTEL

R. Bertel, chief automotive engineer for Repco, Ltd., Melbourne, Australia, died June 27. He was 54.

Bertel began work in the automotive industry at the age of 14. When he was 18 he worked as a mechanic in the Australian Corps Workshops, A.I.F. Overseas.

In 1927 Bertel was manager of Bertel Garage Pty. Ltd., Richmond, and in 1930 was a partner of Bertel & Ledin, Preston. Previously he had worked for L. J. Bottomley in Melbourne and St. Kilda, Economic Motor Engine Co., Melbourne, and Marcus Clark Ltd., Melbourne. In 1936 he was shop manager of Replacement Parts Pty. Ltd., Melbourne.

Born in Windsor, Victoria, Australia, Bertel was a member of the Institute of Automotive Engineers, Australia, as well as the SAE.

Students

RAY EDWARD KOSKIE (Purdue '52) is an ensign, Civil Engineer Corp., U.S. Navy.

ROBERT T. MADISON (Missouri School of Mines, '53) has joined Western Cartridge Co., East Alton, Ill., as a mechanical engineer.

FOSTER W. CUNNINGHAM (Detroit Institute of Technology '53) is with Goodyear Aircraft Corp., Akron, Ohio, as a college trainee in the research and development department.

STANLEY N. MARCUM (Syracuse University '53) is assistant project engineer for Sperry Gyroscope Co., Great Neck, N. Y.

HERBERT H. LEE (University of Michigan '52) is doing engineering liaison work for Piasecki Helicopter Corp., Morton, Pa.

JAMES HOKE PEPIN (Agricultural & Mechanical College of Texas '53) is with Babcock & Wilcox Co., New York, as a student engineer.

MICHAEL VEZZETTI (California State Polytechnic College '52) is a junior engineer for Marchant Research, Inc., Oakland, Calif.

ARDEN C. DEGNER (University of Illinois '53) has joined Fairbanks, Morse & Co., Beloit, Wis., as a junior engineer.

JOHN GEOFFREY TROTTER (University of Saskatchewan '53) is with the Saskatoon Fire Engine Co., Saskatoon, Saskatchewan.

NORMAN DOUGLAS KNOWLES (University of Saskatchewan '53) is at Calgary, Alberta, with the Imperial Oil Co.

HOWELL C. LOWE (Cornell University '53) is with the J. I. Case Co., Racine, Wis.

RICHARD M. ELLIS (Purdue University '53) has joined Westinghouse Electric Corp., Lester, Pa., as a junior engineer.

GEORGE EDWARD HALL (Northrop Aeronautical Institute) is with Douglas Aircraft Co., Inc., Long Beach, Calif.

STEPHEN PALISKA (Princeton '53) has joined the Hamilton Standard Division, United Aircraft Corp., Windsor Locks, Conn.

ARNOLD A. ELSBERND (Parks Air College '52) is stationed at Hunter Air Base, Savannah, Ga., as base photo officer.

JOSEPH R. de MARTINO (Purdue '53) is now working for GMC, Detroit, as a project engineer.

HARRY N. HILL (Northrop Aeronautical Institute '52) is now working in the engineering research laboratory at North American Aviation in Inglewood, Calif.

FARID K. AL-KHUDAIRY (Calif. State Polytechnic College '53) is with the E. C. Livingston Co., Inc., Paso Robles, Calif.

FRANK J. TURNER, JR. (Academy of Aeronautics '52) is with American Airlines, Inc. in Chicago as a line maintenance mechanic.

OSCAR W. DILLON, JR. (University of Cincinnati '51) is with the Cornell Aeronautical Laboratory, Buffalo, N. Y. Dillon was in the U.S. Air Force.

WARREN M. WIESE (University of Minnesota '51) is a second lieutenant stationed at Keesler Air Force Base, Mississippi.

Students Enter Industry

continued

DONALD R. CLARKE (West Coast University '52) is now employed by R. C. A. Victor as a mechanical design engineer.

EWALD F. SCHROEDER (University of Saskatchewan '53) is in the Royal Canadian Air Force.

VERN M. WHELEN (University of Saskatchewan '53) is with the Saskatchewan Power Corp., Gas Dept., Saskatoon.

VINCENT L. POLKUS (Michigan College of Mining and Technology '53) is employed by the Ford Motor Co., Dearborn, Mich., as a project engineer in the chassis group.

GEORGE D. CHENEY (Massachusetts Institute of Technology '53) is with Goodyear Tire and Rubber Co., Akron, in a college training program.

C. HOWARD EGGLETON, JR., (Michigan State College '53) is layout draftsman for Harry Ferguson, Inc., Detroit.

JOSEPH F. DOWNEY (Northrop Aeronautical Institute '53) has joined Douglas Aircraft Co., Inc., Santa Monica, Calif., as an engineering draftsman.

LUCAS L. AKANA (West Coast University '52) is design engineer for Paxton Engineering Co., subsidiary of McCulloch Motors Corp., Los Angeles.

DONALD G. WALLACE (Purdue University '52) is an engineer in training for Perfect Circle Corp., Hagerstown, Indiana.

JAMES HAROLD BEALER (Pennsylvania State College '53) is a junior engineer for The Worthington Corp., Harrison, N. J.

CHARLES A. GRIGGS (Tri-State College '52) is in the development engineering section, Euclid Road Machinery Co., Euclid, Ohio.

ROBERT A. GRIEST, JR., (Swarthmore College '53) is at the U. S. Naval School, Newport, Rhode Island, as an officer candidate, seaman apprentice.

RALPH M. WADLER (Chrysler Institute of Engineering '53) is a chemical engineer for Industrial Rubber Works, Inc., Chicago.

CHESTER A. STRONG (Indiana Technical College '53) is a production design engineer with Glenn L. Martin Co., Baltimore.

ARTHUR R. SHIPE, JR. (Ohio State University '53) has joined the Frigidaire Division of GMC, in Dayton, Ohio, as a tester.

HENRY J. JOHNSON, JR. (Northrop Aeronautical Institute '53) is with the United Aircraft Corp., East Hartford, Conn., as an engineering assistant in the research department.

ROBERT A. DEZELICK (University of Illinois '53) is on the engineering staff of Ford Motor Co., Dearborn, Mich.

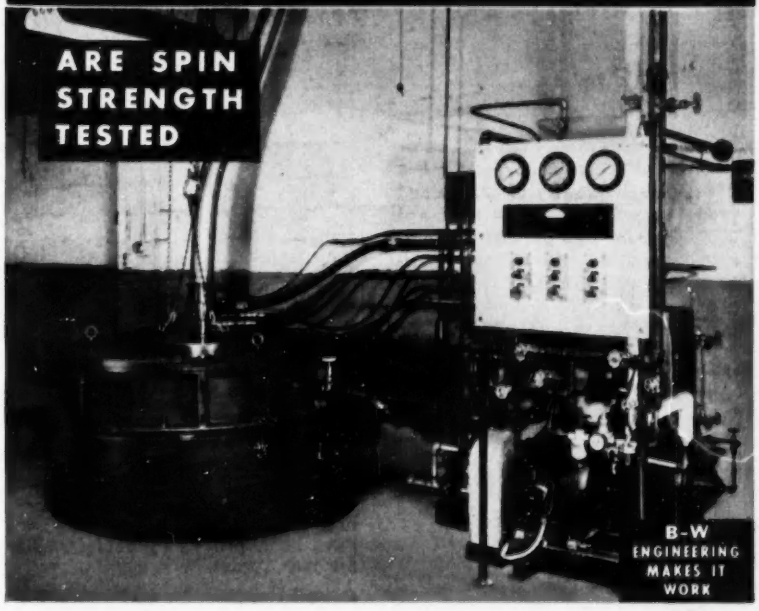
EDWIN S. GILES, JR. (Rensselaer Polytechnic Institute '53) is with Raytheon Mfg. Co., Waltham, Mass., as an engineering assistant.

GEORGE METTEER (University of Southern California '51) is a laboratory test engineer "A" for Airesearch Mfg. Co., Los Angeles.

RANDALL GOFF (University of Michigan '53) is a mechanical engineer for the National Bureau of Standards, Washington, D. C.

Continued on Page 108

ROCKFORD CLUTCHES



To determine the bursting speed of ROCKFORD CLUTCHES, they are spun up to a high R.P.M. in this air turbine speed chamber. This test assures they will continue to perform efficiently at the speeds for which they were designed. Let ROCKFORD engineers devote the benefit of this and many other tests to *your* product's clutch design.



B-W PRODUCTION MAKES IT AVAILABLE

ROCKFORD CLUTCH DIVISION BORG-WARNER
316 Catherine Street, Rockford, Illinois, U.S.A.

Students Enter Industry

continued

GEORGE W. RICHARDSON (University of Connecticut '53) has joined E. I. du Pont de Nemours & Co., Inc., at the Savannah River Plant, North Augusta, S. C.

JAMES C. WILLETT (West Coast University '53) has joined Northrop Aircraft, Inc., in Hawthorne, Calif., as an electrical engineer junior.

WILLIAM J. MOFFITT (University of Massachusetts '53) is with General Electric Co., Schenectady, N. Y., in the manufacturing training program.

DELL BRAMBLE (Tri-State College '53) is now a development engineer for the Clinton Machine Co., Clinton, Mich.

JACK CRAIG GRACE (Ohio State University '52) is with The Ohio State University Research Foundation, Columbus, as research associate.

ROBERT J. BROWNE (Massachusetts Institute of Technology '53) has joined the Ford Motor Co.

ALLEN H. BASSETT (University of Cincinnati '53) is product engineer in the vehicles testing department of Ford Motor Co., Dearborn, Mich.

WILLIAM A. ROCK (Stevens Institute of Technology '53) is production supervisor for Tung-Sol Electric, Inc. in Newark, N. J.

HAROLD C. BRIDWELL (University of Oklahoma '53) is research engineer for Carter Oil Co., Tulsa.

CHARLES D. MARTIN (Northrop Aeronautical Institute '53) is with Republic Aviation Corp., Farmingdale, N. Y., as an engineer trainee.

RICHARD I. HIGASHI (University of Illinois '53) is mechanical engineer at the San Francisco Naval Shipyard.

DANIEL A. LIPPMAN (Massachusetts Institute of Technology '53) is on leave of absence from Goodyear Tire & Rubber Co., Akron, where he has been a staff technical trainee. He is now serving with the U. S. Army.

EDWARD C. ERICKSON (University of Minnesota '53) is with Oliver Iron Mining Co., Duluth, Minn., as a mechanical engineer.

ANKER E. JORGENSEN (Purdue) has joined Ross Gear & Tool Co., Lafayette, Ind., as a design engineer.

ANDREW E. FEINER (Cornell University '53) is a mechanical engineer for Carrier Corp., Syracuse, N. Y.

ROBERT E. GILLINGHAM (California Institute of Technology '53) is engineering assistant in missile research for Northrop Aircraft, Inc., Hawthorne, Calif.

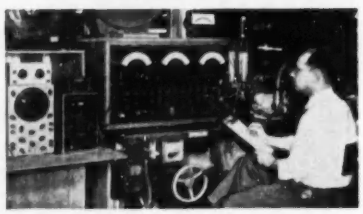
T. E. K. KNOLNER (Case Institute of Technology '52) is with Trans World Airlines, Inc. in Kansas City, Mo., as an engineer.

JAMES M. MICHAELS (New York University '53) has joined the General Electric Co., Aircraft Gas Turbine Division, Lockland, Ohio, as a design engineer.

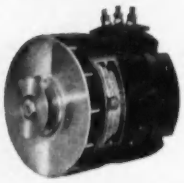
JAMES F. COVINGTON (University of Washington '51) is now employed by the Pacific Car and Foundry Co. in Renton, Wash. Covington, who was in service, is in the methods analysis department.

BRING YOUR ELECTRICAL PROBLEMS TO Leece-Neville

In four decades of service to the automotive industry, Leece-Neville has developed the ability to design and produce special units. Our staff and equipment for this purpose are outstanding and we welcome the opportunity to custom-engineer special and heavy-duty electrical equipment to meet particular problems.



For Example: Alternator Systems



Leece-Neville has developed dozens of different models of AC-DC Alternator Systems for such applications as passenger car, truck, bus, off-highway, railroad and marine. They have been proved by performance for over 7 years.

Capacity ranges for various system voltages include: to 95 amps for 6 volt; to 180 amps for 12 volt; to 100 amps for 24 volt; to 50 amps for 32 volt.

As in all Leece-Neville units, rugged design and precision manufacture combine to give L-N Alternators unmatched reliability and extreme life. Be sure to specify Leece-Neville. For all the facts, write The Leece-Neville Company, Cleveland 14, Ohio.

L-N custom-engineered products include:

ALTERNATOR SYSTEMS
D. C. GENERATORS
CRANKING MOTORS
SMALL MOTORS FOR HEATERS, etc.
REGULATORS
SWITCHES
AIR CRANKING MOTORS

YOU CAN RELY ON Leece-Neville

CUSTOM ENGINEERED ELECTRICAL EQUIPMENT SINCE 1909

TRUCK BUS DIESEL OFF HIGHWAY PASSENGER RAILROAD MARINE INDUSTRIAL

Continued from Page 95

sure were further reduced to the correct altitude value, since the engine will be insensitive to exhaust pressure. The jet thrust of the engine at the actual exhaust pressure condition can be adjusted to the jet thrust obtainable at the simulated altitude condition by adding to the measured thrust the product of exhaust nozzle area and the difference between the actual and desired exhaust static pressures.

When the extension of operating limits obtained with an exhaust diffuser is applied to those for choked nozzle operation, the maximum altitude limit is raised further, as shown in Fig. 2. In this instance a 1.14 area ratio diffuser is employed. Taking advantage of the gains provided by the diffuser further raises the maximum limit by about 6000 ft. (Paper, "Turbojet Research Techniques Utilized in Altitude Facilities" was presented at SAE National Aeronautic Meeting, New York, April 22, 1953. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers.)

Volatile Corrosion Inhibitors Under Test

Based on paper by

GORDON S. MUSTIN

Bureau of Aeronautics
Department of the Navy

SEARCH for a really satisfactory method of controlling corrosion has led the military to focus attention on volatile corrosion inhibition. The essence of this method is the use of an inhibitive chemical with sufficient vapor pressure to bring about sublimation on the surface to be protected.

The sublimed molecules are usually polar. One end wets the metal preferentially, displacing any water already there. The other end is hydrophobic, barring water from penetrating the sublimed film.

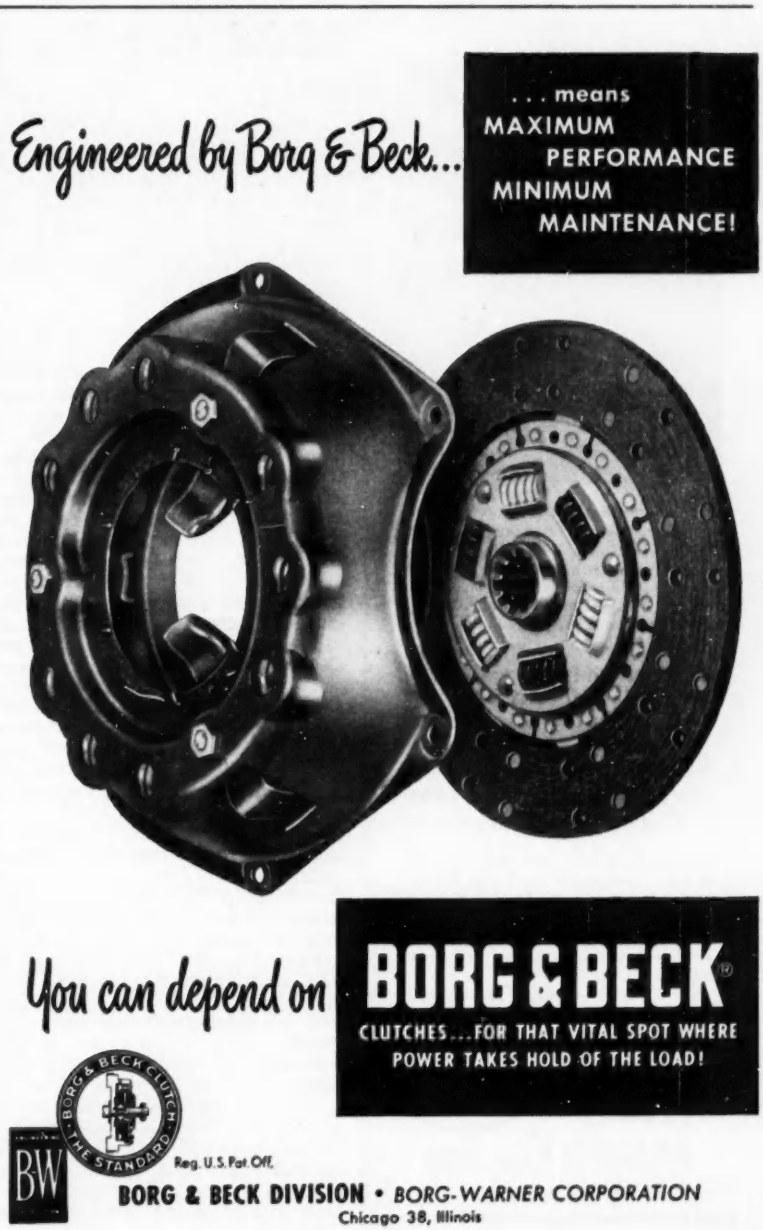
Further investigation will be needed as the following comments on problems will indicate:

(a) Development of better inhibitors. At present most of them are types which don't attack iron and steel, but may harm other metals under certain circumstances. Definite protection for all non-ferrous alloys would be desirable.

(b) Better heat stability. The amine nitrite types break down to give corrosive by-products, notably nitrosamines and nitrous acid. While the critical temperature will vary, it is too close to 180 F for comfort. Such temperatures have been recorded in the interior of boxes stored in the open in the tropics.

(c) Better resistance to acid. Current materials break down in the presence of acids to give corrosive by-products. The amount of acid required for this reaction is very small. Disastrous results have been reported where parts were processed in a poorly controlled vapor degreaser and residues were not completely removed.

(d) Effects on barriers. Definite

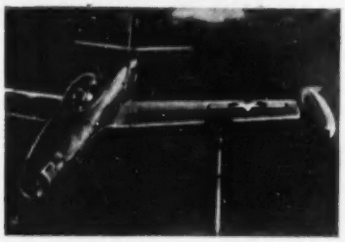


transmission through various barriers has been observed, and the rates of transmission need to be determined. Some barriers of the MIL-B-131 type are delaminated after exposure to some of the inhibitors.

In spite of drawbacks, the method offers great promise on primarily ferrous items, especially where simplified depreservation, possibly under combat conditions, is desirable. Experience in industry, where exposure conditions are possibly not quite so severe, has been excellent, and further adaptations to military use can be expected. (Paper, "Corrosion Control in Military Packaging" was presented at SAE Summer Meeting, Atlantic City, June 8, 1953. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers).



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Air Conditioned Cars Definitely on the Way

Based on paper by

L. L. KUEMPEL

Keco Industries

AUTOMOBILE air conditioning has developed little since 1938. Present-day compressors are slightly better, but that's all. Cars are still not designed to accommodate air conditioning and annual changes are sufficient to handicap application of existing equipment.

But the future is extremely promising. With assurance of public interest and the resulting economic urge, the various problems will melt away. The automobile itself is showing signs of accommodating air conditioning, if only because engines are growing smaller at a faster rate than hood space, and because of the uniformly large trunk compartments. There is a growing trend to soundproofing insulation and a reversal of the trend toward freely ventilated bodies. And such items as sun visors and heat-absorbing glass cut down heat again.

Rear engine drive would answer the basic problem of draftless air distribution. It would eliminate the hot and air leaking fire wall, and permit front installation of air handling equipment. The lessened capacity requirements and the lessened cfm would be very helpful. Coupled with this is the simple fact that people can stand far more air velocity in the face than in the neck. It is possible to keep a person comfortable by merely blowing a small volume of cool air toward his face. To surround him with air requires a much greater volume.

A constant-speed accessory drive would be very helpful in cutting power loss from the radiator fan and simplifying electrical generator problems. It would be an ideal mechanical drive source for the compressor and for driving a compact 110-v 60-c alternator for powering all accessories as well as an air conditioner using an hermetically sealed compressor. One

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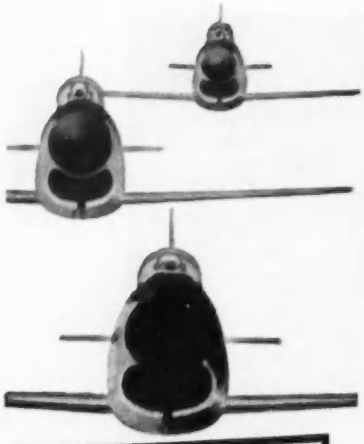


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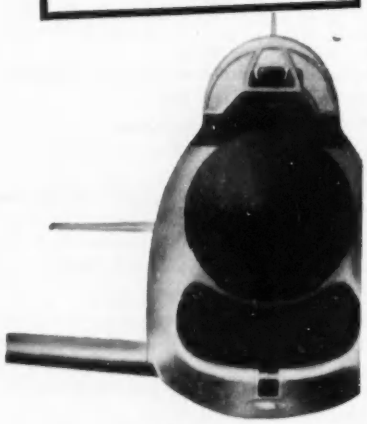
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of the basic shortcomings of existing compressors is the requirement for a refrigerant tight seal at the drive shaft. Seals are improving but not as fast as the balance of the compressor, and automobile duty is especially hard on them. The induction motor driven hermetic compressor is the best answer to compressor reliability, but this requires regulated a-c. (Paper, "Trends in Automotive Air Conditioning" was presented at SAE Cincinnati Section, January 26, 1953. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to non-members.)

Many Factors Affect Tappet Face Durability

Based on paper by

RALPH P. HORAN

Eaton Mfg. Co.

This paper appears in full in the SAE 1953 Transactions

TAPPET face stresses, alignment, material combinations, finish and manufacturing technique, surface coatings and lubricants all influence the life of the mating parts. To isolate each factor and determine its exact influence is extremely difficult.

When a flat face is used on the tappet and the alignment with the cam is perfect under all operating conditions, the contact is across the entire width of the cam, which results in low stresses. But if the tappet bore or the camshaft is not perpendicular, due to manufacturing tolerances or the deflection of the parts, edge bearing is possible and that causes a very high stress. Use of a spherical face tappet may overcome the trouble, and if employed, it is wise to taper and offset the centerlines to insure tappet rotation.

New Approach

One new approach to the alignment problem is to use a so-called hyperbolic tappet which has its side contoured so as to permit the face to accommodate itself to any misalignment. This design combines the advantages of the flat face with its lower stress and alignment.

When material combinations are considered, experience shows that it is best to use a chilled cast-iron tappet face when running against a steel camshaft. If a cast-iron shaft is used, equally good results can be had with a cast-iron or steel tappet face.

The coatings commonly used on tappet faces are ferrox and parco-

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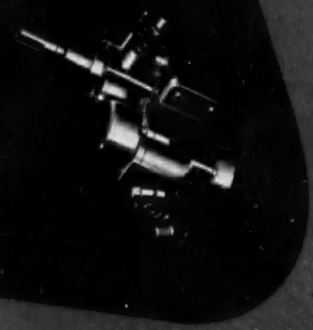
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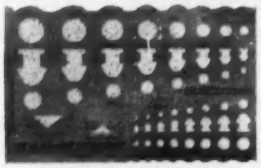
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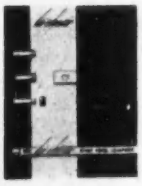
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lubrite. The ferrox treatment cannot be applied to hardenable irons and steels because of the temperature of application. In general, the ferrox treatment has proved superior to lubrited surfaces for the chilled tappet face. Experience with other surface treatments is too limited to warrant any conclusions. Variations in lubricants have been found to affect tappet life, and oil "film strength" has also been found to be an influencing factor. (Paper, "Overhead Valve Gear Problems" was presented at SAE National Passenger Car, Body, and Materials Meeting, Detroit, March 5, 1953. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers).

How to Calculate True Valve Motion

Based on paper by

PHILIP BARKAN

Pennsylvania State College

This paper appears in full in the 1953 SAE Transactions

THE cam designer, says the author of this paper, must rely mainly on empirical knowledge to anticipate difficulties arising from the use of the flexible, overhead linkage. As an outcome the development of a high-speed overhead valve mechanism is frequently an expensive trial-and-error process. Even where elaborate theoretical analyses have been employed, the element of unpredictability, although lessened, still persists.

Method Assists Designer

In this paper is presented a method of calculating the true motion of a valve which is actuated by a cam through a flexible linkage. It employs a numerical method of calculation which is ideally suited for digital type automatic computers. The method is intended to assist the designer in understanding the valve motion phenomenon and enable him to predict motion quantitatively, with sufficient accuracy at a given speed and a given valve lash. (Paper, "Calculation of High Speed Valve Motion with a Flexible Overhead Linkage" was presented at SAE National Passenger Car, Body, and Materials Meeting, Detroit, March 5, 1953. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers.)

Study Throws New Light on Engine Knock

Based on paper by

D. R. DIGGS

E. I. du Pont de Nemours & Co.

This paper will be printed in full in the 1953 Transactions

IN order to explore the relationship between combustion time and knocking tendency and to investigate the practicality of high mass rates of burning, a study was made with a single-cylinder engine in which it was possible to vary combustion time by multiple ignition at otherwise fixed engine operating conditions.

As an outcome of this investigation, the following conclusions could be drawn:

1. Under a variety of engine conditions generally representative of normal operation, a significant decrease in engine octane requirements can be realized when the combustion time is decreased by firing 17 spark plugs simultaneously instead of firing one plug in the normal location.

2. When the combustion chamber contains deposits, the octane requirement decrease obtainable by the use of multiple ignition is less than when deposits are not present.

3. When using single ignition, the location of the end gas is as important as the combustion time in determining the engine octane requirement. (Paper, "The Effect of Combustion Time on Knock in a Spark Ignition Engine" was presented at SAE Annual Meeting, Detroit, Jan. 16, 1953. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers).

"Flying Labs" Essential to Research

Based on paper by

R. J. SANDSTROM

Bell Aircraft Corp.

THE wind tunnel, the altitude chamber, the high-speed computer all render indispensable service to the aircraft designer. But all of them combined cannot reveal conclusively what a full-scale plane will do when brought into concrete relationship with the



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myriad variables of flight beyond proven frontiers. Therefore, the research airplane must take over for final proving.

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1. As a research tool in the transonic and supersonic region to fill the gap between sub and supersonic tunnels, supplying quantitative data of many varied types for use of designers and engineers of future planes.
2. As "the proof of the pudding" to demonstrate the validity of various theories and the applicability of various laboratory results in full-scale, actual, trans- and supersonic flight.
3. As a flying test bed for new instruments, accessories, and equipment for both aircraft and guided missiles, under conditions of speed, altitude, and temperature never before encountered.

(Paper, "Flying Laboratories" was presented at SAE Cleveland Section, Cleveland, Dec. 8, 1952. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers.)

Hydraulic Steering Dampens Road Shocks

Based on paper by

C. W. LINCOLN
Saginaw Steering Gear Division, GMC

WHILE the primary purpose of the hydraulic gear is to reduce steering effort, the dampening of road shocks is an important advantage. Impacts of any consequence immediately compress the valve centering springs, closing the valve momentarily, and imposing against the piston a solid block of incompressible hydraulic fluid. This forestalls the tendency to rotate the wheel suddenly which would be felt in a manual gear.

The Saginaw hydraulic gear has been designed to revert automatically to a normal manual gear in the event of hydraulic failure. This was done to assure car owners who might be suspicious of the new device's reliability. The ratio of gears now in production is 21.3, identical, for example, with the manual gear of the Cadillac. Here again, car owners have been considered. If a reduction in ratios was made too quickly, owners would have to unlearn habits acquired through many years of high ratio steering. Furthermore, in the event of hydraulic failure, there will be no greater difficulty in handling the car than there was before with manual steering.

With the Saginaw gear the loads of the centering springs and even the size or number of the reaction plungers can be varied to make the steering "firm" or "soft" as desired. Also, basic elements of the gear can be arranged in a variety of ways to take advantage of available space in the car layout. (Paper, "Hydraulic Steering in General Motors Cars" was presented at SAE St. Louis Section, St. Louis, Feb. 5, 1953. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers).

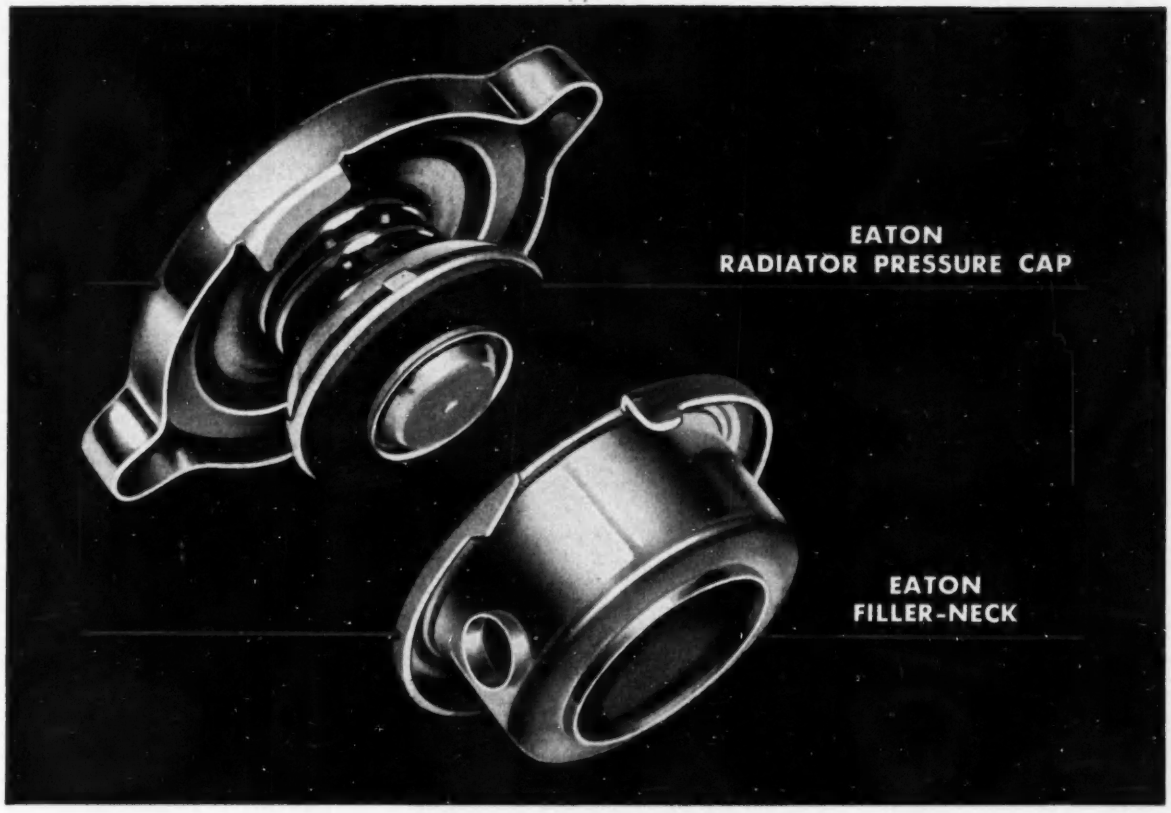


Predicting Pneumatic System Pressure Drops

Based on paper by

MILTON M. SLAWSKY
National Bureau of Standards
ALBERTUS E. SCHMIDLIN
Walter Kidde & Co., Inc.
and
MORTON LUTZKY
National Bureau of Standards

IN this paper, the authors present a method for predicting pressure drops in pneumatic components and systems. As an outcome of their investigations, they found that the performance of a fixed-orifice pneumatic component, under given operating conditions, can be predicted to within ±5% accuracy, by consideration of the upstream conditions and only one numerical parameter, called the flow factor. The flow factor is a constant for the valve and, once determined, either by experiment



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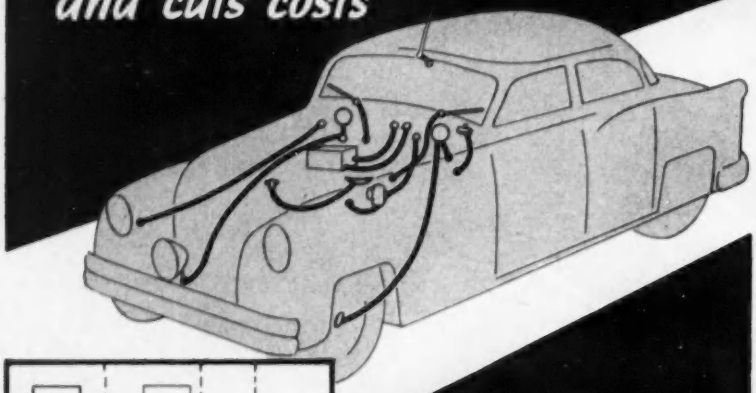
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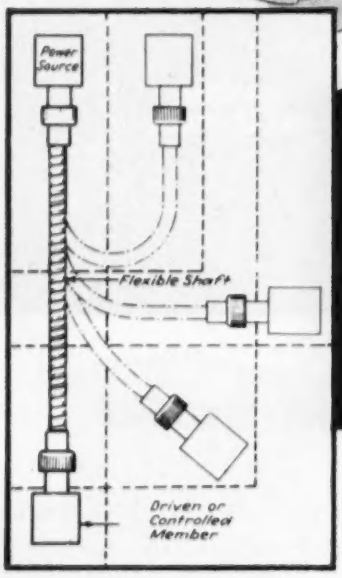
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or by theory, can be used to predict valve performance for a wide range of upstream conditions. It is also possible to combine analytically the flow factors of a number of valves into an overall flow factor for determining the behavior of a more complex system composed of separate valves in series.

As part of their presentation, which includes formulas and charts, the authors describe a method of plotting flow data, called the method of characteristic curves, which is essential to an understanding of the flow factor. (Paper, "A Method for Predicting Pressure Drops in Pneumatic Components and Systems," was presented at SAE National Aeronautic Meeting, New York, April 22, 1953. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers.)

New Method Speeds Preignition Detection

Based on paper by

R. F. WINCH
and
F. M. MAYES

Sun Oil Co

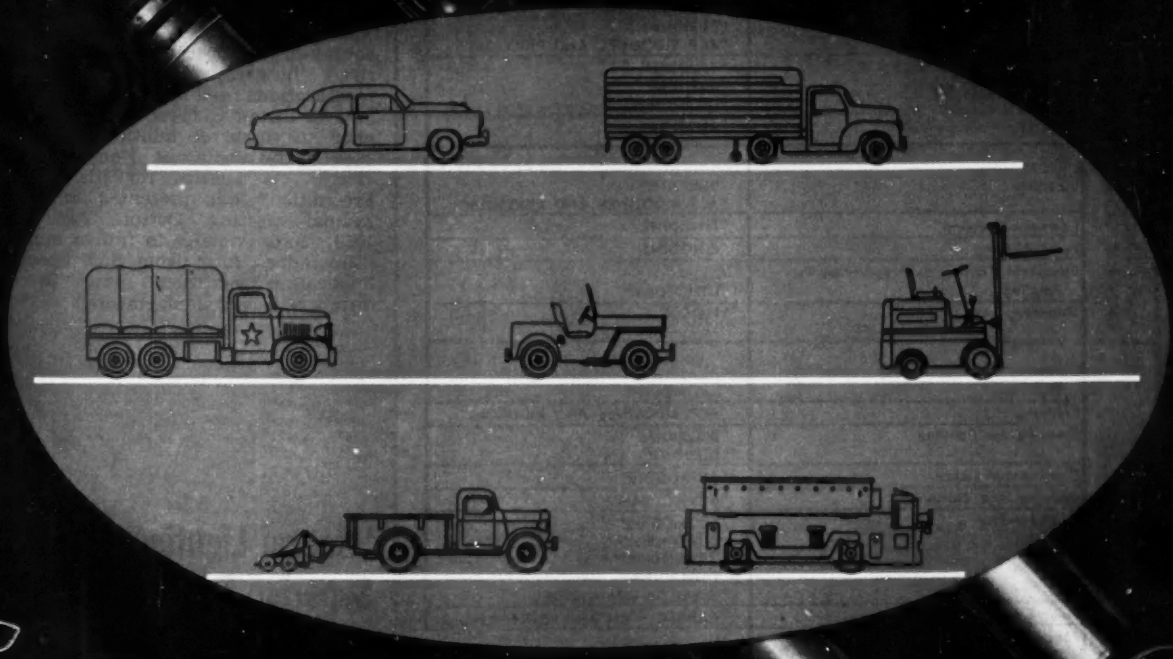
This paper appears in full in the 1953 SAE Transactions

THERE has been developed at the Sun Laboratory a simple and accurate method for detecting and measuring preignition. This method is not only sensitive to mild preignition, regardless of the location of the source, but it is also able to distinguish between preignition and detonation, and capable of producing accurate and reproducible results.

It works on the principle that electrical properties of the spark plug gap will vary, depending on the time in the cycle at which combustion is initiated and on the rate at which the combustion process is completed, i.e., whether or not secondary flame fronts are present. Specifically, changes occur in the conductivity of the gap which are reflected in variations in current flow. These variations, when observed on an oscilloscope, serve as an excellent means of detecting the presence of abnormal combustion.

To use this principle to best advantage, the normal current flow associated with the spark discharge has been supplemented by the use of a constant d-c voltage across the gap. The difference between the current flow pattern produced on the oscilloscope dur-

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ing a preigniting cycle and a normal combustion cycle is sufficiently great that the change from the normal pattern is easily seen. Detonating combustion, on the other hand, does not disturb the normal combustion pattern unless the knock becomes excessively severe.

Many of the disadvantages of previous methods appear to have been overcome by this newest development. That's because it is simple, easy to construct and operate, and comparatively inexpensive. No mechanical modifications need be made in the engine to install it. And it can be applied to single or multicylinder engines in the laboratory or on the road. (Paper, "A Method for Identifying Preignition" was presented at SAE Annual Meeting, Detroit, Jan. 16, 1953. It is available in full in multilithographed form from SAE Special Publication Department. Price: 25¢ to members; 50¢ to nonmembers.)

Integral Lighting Superior for Aircraft

Based on paper by

J. H. ACHILICH

Special Devices Center
Office of Naval Research

STUDY of existing systems for cockpit instrument lighting lead us to conclude that integral lighting of the individual instrument offers the best solution to the problem of cockpit panel lighting. We have also decided that the light source should be incorporated at the center of each instrument.

As conceived and developed at the Special Devices Center, the basic system employs a light installation in the center of the instrument window, with dials and pointers of translucent material. The seven goals sought appear to have been achieved. Briefly, they are:

1. Lighting installation to be a part of each instrument.

2. Lamp to be accessible and replaceable from the front.

3. Light distribution to be uniform and all information clearly visible.

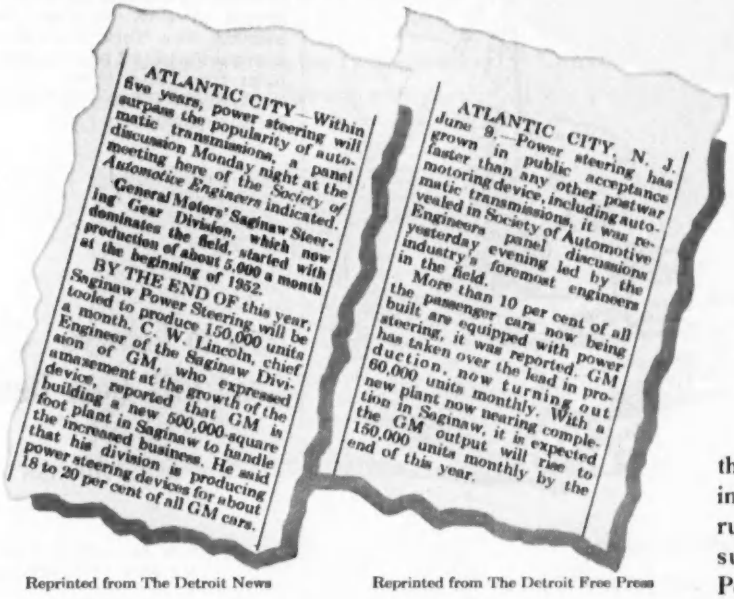
4. No rework of instrument activating mechanism shall be necessary, thereby permitting existing type instruments to be modified.

5. Ability to present instrument in-

SAGINAW LEADS RECORD-BREAKING SWING TO POWER STEERING



Almost Everywhere You Look—Tradepapers, Newspapers, National Magazines—Power Steering is *Making Headlines!*



ATLANTIC CITY—Within five years, power steering will surpass the popularity of automatic transmissions, a panel discussion Monday night at the meeting here of the Society of Automotive Engineers indicated.

General Motors' Saginaw Steering Gear Division, which now dominates the field, started with production of about 5,000 a month at the beginning of 1952.

BY THE END OF this year, Saginaw Power Steering will be tooled to produce 150,000 units a month. C. W. Lincoln, chief Engineer of the Saginaw Division of GM, who expressed amusement at the growth of the device, reported that GM is building a new 500,000-square foot plant in Saginaw to handle the increased business. He said that his division is producing power steering devices for about 18 to 20 per cent of all GM cars.

Reprinted from The Detroit News

ATLANTIC CITY, N. J. June 9.—Power steering has grown in public acceptance faster than any other postwar motoring device, including automatic transmissions, it was revealed in Society of Automotive Engineers panel discussions yesterday evening led by the industry's foremost engineers in the field.

More than 10 per cent of all the passenger cars now being built are equipped with power steering, it was reported. GM has taken over the lead in production, now turning out 60,000 units monthly. With a new plant now nearing completion in Saginaw, it is expected the GM output will rise to 150,000 units monthly by the end of this year.

Reprinted from The Detroit Free Press

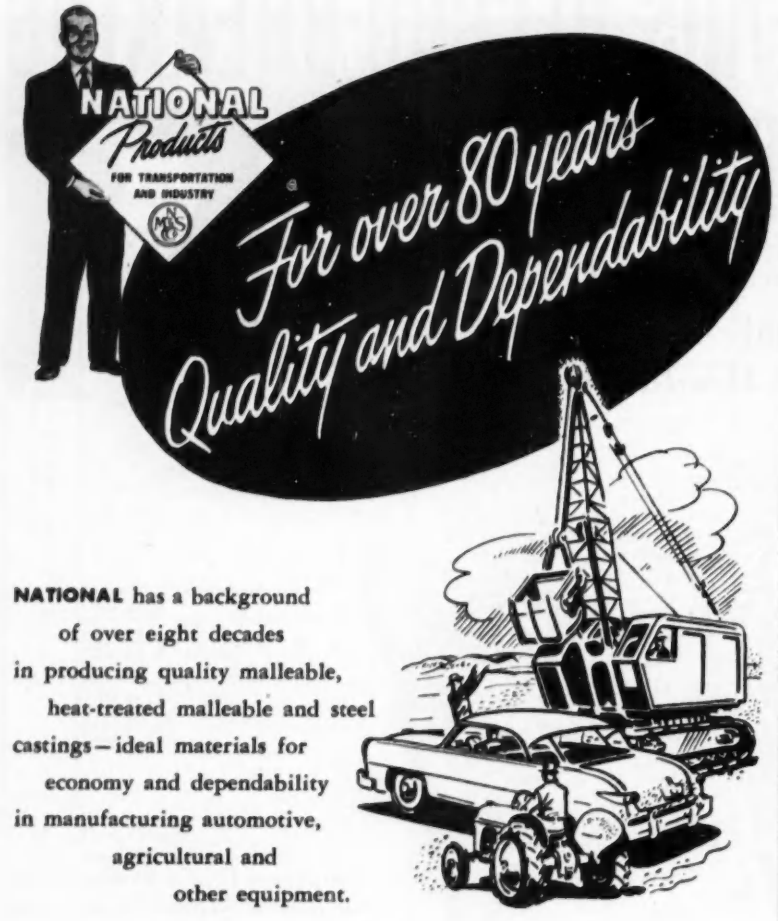
Yes—Power Steering is the *biggest news* in the automotive industry today—and the biggest news in Power Steering is *Saginaw!* Saginaw Power Steering—*with the built-in "feel of the road" that eliminates any tendency to oversteer*—is now available on all General Motors cars and three other well known makes. Nearly 600,000 drivers are already enjoying it, and *more Saginaw units are being built than all other makes combined.*

The demand for Saginaw Power Steering is growing so rapidly that a new 11 acre Power Steering plant in Saginaw is now being rushed to completion. There is such widespread interest in Power Steering that we believe every automobile man will want to be well-informed about it. To help give you a better understanding of this important new development, we have prepared an interesting little booklet, "THE FACTS ABOUT POWER STEERING", that's yours for the asking. Shall we send you a copy?

Saginaw

POWER STEERING

SAGINAW STEERING GEAR DIVISION, GENERAL MOTORS CORPORATION, SAGINAW, MICHIGAN



NATIONAL has a background of over eight decades in producing quality malleable, heat-treated malleable and steel castings—ideal materials for economy and dependability in manufacturing automotive, agricultural and other equipment.

NATIONAL's unparalleled experience—coupled with a continuing metallurgical research program, rigorous quality control standards, and completely mechanized foundries in strategically located cities—is at your disposal.

Sales offices and engineering facilities are located at all five plants listed below.



A 16mm Technicolor film. Narrated by Edwin C. Hill, this 27-minute film tells how malleable iron is made . . . tested . . . used . . . how its production economy, ductility, machinability, toughness will give you a better finished product. Available for group showings. A-5017

PLANTS LOCATED IN

Sharon, Pa., Cleveland 6, Ohio, Indianapolis 6, Ind., Melrose Park, Ill., and Chicago 50, Ill.

NATIONAL MALLEABLE and STEEL CASTINGS COMPANY
CLEVELAND 6, OHIO

NATIONAL Products FOR TRANSPORTATION AND INDUSTRY Est. 1868

formation at low levels of illumination, thereby achieving optimum dark adaptation.

6. Brightness level to be adjustable to provide adequate brightness for various conditions.

7. A minimum of light spill from the instrument onto the instrument panel.

The study indicated that the overall presentation of instrument data should be reviewed and human engineered to give the simplest, concise indication for the aircraft pilot's observation, under integrally lighted transilluminated conditions. A case in point would be the elimination of figures on part of the dial never used. (Paper, "Aircraft Instrument Integral Lighting" was presented at SAE National Aeronautic Meeting, New York, April 23, 1953. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers.)

How to Achieve Good OHV Gear Design

Based on paper by

M. C. TURKISH

Eaton Mfg. Co.

This paper appears in full in the 1953 SAE Transactions

THE valve gear is a composite mechanical system with the functional characteristics of all the component parts closely inter-related. Performance of the valve spring is dependent upon cam design, valve gear dynamics at high speed, and the characteristics of the hydraulic lifter. In like manner, the performance of any one of the other three elements is related to the characteristics of the other three acting as controlling parameters. The best approach to obtaining a well performing overhead valve gear for a high speed passenger car engine, using hydraulic lifters, appears to be:

1. Use an acceleration curve having a smooth or parabolic type positive acceleration which blends in smoothly with the negative acceleration. Rapid changes in acceleration are undesirable and the magnitude of the positive acceleration should be limited to a maximum of five times the negative acceleration.

2. Use a valve gear having proper weight distribution consistent with obtaining maximum rigidity to secure a

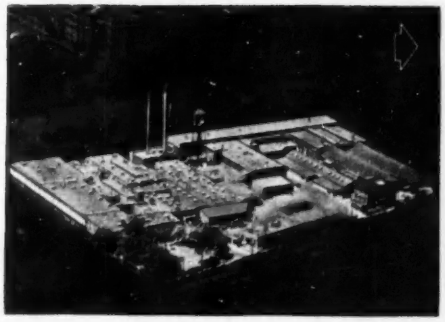
Thompson increases facilities

to better serve the automotive industry

In order to keep pace with demands for improved chassis and steering parts, including the new, revolutionary Thompson-engineered ball joint for front suspension, we have added two new manufacturing plants at Fruitport, Michigan and at Portland, Michigan.

These two new plants enable Thompson to give you even better service and deliveries.

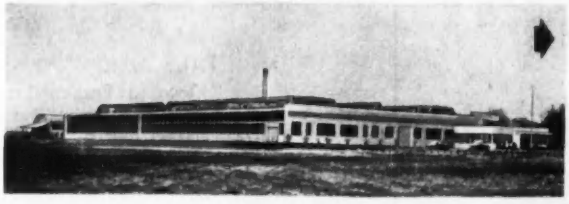
We invite you to investigate the numerous advantages of working with the expanded Michigan Plant of Thompson Products . . . of having your engineers work with the experienced Thompson engineers in solving your problems. Write, wire or telephone Thompson Products, Inc., 7881 Conant Avenue, Detroit 11, Michigan. WA 1-5010.



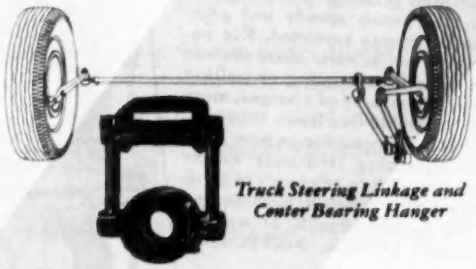
DETROIT MICHIGAN PLANT



Passenger Car Steering Linkage



PORTLAND MICHIGAN WORKS



Truck Steering Linkage and Center Bearing Hanger



FRUITPORT MICHIGAN WORKS



Ball Joint for Front Suspension

You can count on

Thompson Products

MICHIGAN PLANT

DETROIT • FRUITPORT • PORTLAND

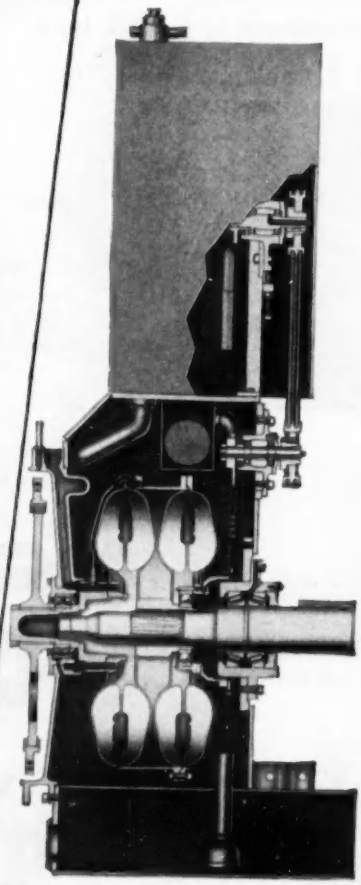
NEW Model HUD Disconnecting Hydraulic Power Take-Off . . .

Reduces Impact Shocks 70%

Doubling wear life on chains, clutches and running parts, drilling rigs equipped with the new Twin Disc Disconnecting Hydraulic Power Take-Offs have been running up outstanding service records during the past two years. Many rigs now drill deeper, more economically, because the new Twin Disc Model HUD allows the *full use of peak engine torque . . .* dampens starting shocks, stopping shocks and overloads. Through the complete Disconnect feature, the HUD acts as a master clutch.

Steady power transmission through Twin Disc HUD softens and controls speeds of acceleration and deceleration . . . to reduce impact shock—on power units *and* driven equipment—by 70% or more. Compounded drives can easily be synchronized—drum clutches can safely be engaged with engines idling, for smoother load pick-up—the range of available mud pump speeds and pressures can be greatly extended. Rig engines, free to run at their most efficient rpm, *prevented* from lugging or stalling under load, are assured of a longer, more serviceable, trouble-free life.

For complete information on how Twin Disc Disconnecting Hydraulic Power Take-Offs are adding efficiency to modern drilling rigs, contact your nearest Twin Disc Factory Branch, or write to the Hydraulic Division, Rockford, Ill.



Twin Disc Model HUD Disconnecting Hydraulic Power Take-Off—available in coupling sizes 21" and 27"; to handle 60 to 600 hp engines . . . operates with either cooling radiator or heat exchanger . . . incorporates shortened oil sump to fit rig design.

Built for a Long Life . . .
Backed for a Lifetime

TWIN DISC
CLUTCHES AND HYDRAULIC DRIVES

TWIN DISC CLUTCH COMPANY, Racine, Wisconsin • HYDRAULIC DIVISION, Rockford, Illinois

BRANCHES: CLEVELAND • DALLAS • DETROIT • LOS ANGELES • NEWARK • NEW ORLEANS • SEATTLE • TULSA

relatively high valve gear frequency of 40,000 to 50,000 cpm, or higher.

3. Match the cam design to the valve gear to obtain a lower critical speed above 4200 rpm.

4. Use hydraulic lifter designs having low pump-up tendencies or possessing anti-pump-up characteristics to permit using reasonably low valve closed spring loads.

5. Use high frequency valve springs and employ some spring surge damping method when operating below the seventh harmonic.

6. Use dual valve springs.

7. Process valve springs by a precision shot-peening technique and preset whenever possible.

(Paper "The Relationship of Valve Spring Design to Valve Gear Dynamics and Hydraulic Lifter Pump-Up" was presented at SAE National Passenger Car, Body, and Materials Meeting, Detroit, March 5, 1953. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers.)

Seat Distortion Curtails Valve Life

Based on paper by

JOHN A. NEWTON

and

M. J. TAUSCHEK

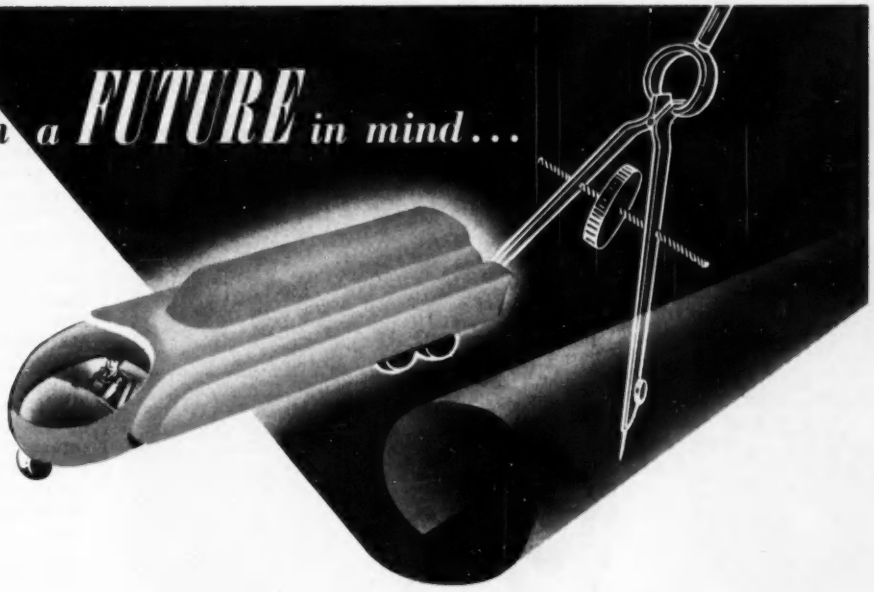
Thompson Products, Inc.

VALVE seat distortion appears to be the factor limiting valve durability and, therefore, the most important problem in the majority of new high-speed engines. It aggravates the conditions which lead to valve burning, and it produces high mechanical stresses in the underhead section of the valve, which lead to valve breakage if allowed to continue. Pounded valve faces and underhead erosion, frequently miscalled "stretching," are indications of seat distortion.

There is no simple formula for correcting valve seat distortion. The best approach is to correct cylinder-head design and prove out the changes experimentally. If vapor phase of coolant is found in critical passages, the obvious correction is to open up the coolant passages. Without cylinder redesign, it is sometimes possible to get significant improvement in coolant temperatures by proper location of flow tubes, by directing the flow of coolant on critical areas.

There are a number of items which

designed with a FUTURE in mind...



BORG-WARNER

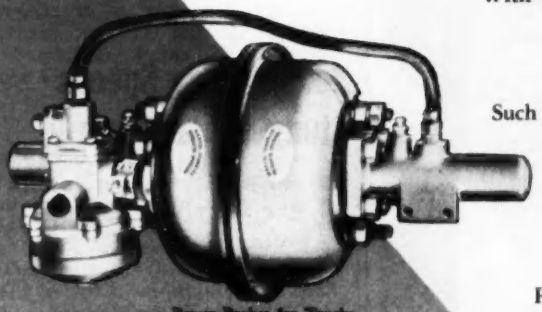
MARVEL-SCHEBLER

With traffic congestion and highway hazards becoming even more critical as time goes on, automotive products must be geared for the years ahead.

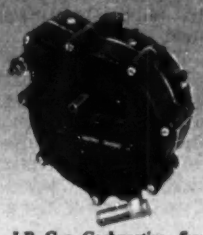
Such is the case with Borg-Warner Power Brakes . . . engineered to fit each vehicle and load requirement. This means *added* protection for both equipment and manpower.

Fleet owners depend on Borg-Warner Power Brakes to meet their braking requirements.

Another example of why "Borg-Warner Equipped" is a magic phrase in the automotive industry!



Power Brakes for Trucks



LP Gas Carburetion Systems for Truck and Tractor Conversion



Gasoline Carbureters for Tractors, Industrial and Aircraft Engines

MARVEL-SCHEBLER *Products Division*

BORG-WARNER CORPORATION · DECATUR, ILLINOIS



can be designed into an engine. These are: faced valves, faced and coated valves, the sodium-cooled valve, which reduces valve head temperatures 200 to 300 F, and the use of soft valve insert material. Soft inserts are made of a highly corrosion resistant material, which resists deposit formation and allows for the pounding in of the valve to give a good seating surface. The flexible design of insert allows for distortion of the cylinder head in the area where the greatest heat is localized without exerting stress on the insert, and allowing the insert to be held in by a shrink fit in a relatively cool section of the exhaust port. High cost limits its use to a very few applications.

Best of all for minimizing the effects of seat distortion is the positive valve rotator. This unit, by imparting positive rotation to the valve, prevents the occurrence of hot spots at any one point of the valve, and thus gives the valve a two to five times longer life. (Paper, "Valve Seat Distortion" was presented at SAE National Passenger Car, Body, and Materials Meeting, Detroit, March 5, 1953. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers).

New System Speeds Study of Cam Profile

Based on paper by

R. A. ROGGENBUCK

Ford Motor Co.

This paper appears in full in the 1953 SAE Transactions

IN this paper the author describes a system for studying the characteristics of a cam so as to be able to design the cam profile for low vibration at high speed. By this system, which permits the use of a mechanical differential analyzer to effect great savings in time, certain general rules for cam design are developed. The author also describes ways in which this study is being expanded with the use of an analog machine. (Paper, "Designing the Cam Profile for Low Vibration at High Speed" was presented at SAE National Passenger Car, Body, and Materials Meeting, Detroit, March 5, 1953. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers.)

New Members Qualified

These applicants qualified for admission to the Society between July 10, 1953 and August 10, 1953. Grades of membership are: (M) Member; (A) Associate; (J) Junior; (SM) Service Member; (FM) Foreign Member.

Atlanta Group

Robert E. Eason, Sr. (M), Robert C. Loman (M).

Baltimore Section

Benjamin Goldfarb (A).

British Columbia Section

James Arthur Rice (M), Kenneth Howard Wilson (J).

Buffalo Section

Donald R. Dreas (A), Raymond Hartman (M).

Canadian Section

Alan Wells Bennett (A), Dennis Henry Milnes (M), Robert C. Smith (A), Leslie Arnold Thompson (M), William August Vahs (M), Charles Douglas Wright (M).

Central Illinois Section

Donald C. Barrick (J), Oscar S. Beckham, Jr. (J), Ray R. Laughlin (M), John H. Parks (M), William James Robb (J), Victor A. Woodling (M).

Chicago Section

Joseph F. Bower (M), Harry H. Bostrom (M), Richard M. Fegan (A), Melvin M. Hann (M), C. W. Leslie (A), Henry B. Nelson, Jr. (M), Emil L. Pesek (A), Willis H. Risse (M), Louis E. Ruffolo (J), Frederick A. Shen (M), Henry A. Weatherhead (A), Walter J. Zwierzycki (M).

Cincinnati Section

Sherman E. Crites (M), Clarence H. Slayton, Jr. (M).

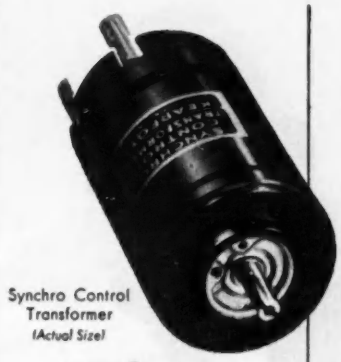
Cleveland Section

Earl T. Andrews (M), William A. Betz (J), Frank E. Dresner (M), (Miss) Elizabeth A. Fathauer (J), Philip Hermann (M), Thomas D. Hogen (M), Frederick P. Salzman (M), Frank L. Snyder (A), William G. Webster (J).

Dayton Section

James E. Ballmer (J).

Continued on Page 128



Synchro Control Transformer *(Actual Size)*



Geared Servo Motor *(Actual Size)*



Servo Motor-Tachometer Generator *(Actual Size)*

miniature
precision components
for high-performance

Servo Systems

Developed and produced by Kearfott, these units exemplify accomplishments of creative engineering teamed with production skill providing performance values of accuracy, speed of response and reliability unique for their size. Advanced design techniques are typified by the unitized stator and housing construction, permitting line-bored relationship of stator and rotor. This makes practical the extremely close concentricity tolerances apparent in improved efficiency of the Servo Motors and the very high accuracy of the companion Synchro. A very rugged structure, stable under extremes of environmental exposure is also provided.

Conforms to Navy BuOrd Size 11
(Maximum Diameter 1-1/16")

TECHNICAL INFORMATION

Synchro—Available as Control Transformer, Transmitter, Resolver, Differential, for 26 or 115 volt 400 cycle operation. Maximum error tolerance is 7 minutes of arc. The hardened pinion shaft may be used as a spline. Terminals for convenient installation and replacement are provided. Other synchros for 60 cycle operation may be obtained. (Basic Type R500).

Servo Motor—The Servo Motor (Basic Type R119) features a very high torque-to-inertia ratio. Motor input is 3.5 watts per phase at 115 volt 400 cycle. Available with high-impedance control winding for operation directly in plate circuit of an Amplifier. Integral precision gear train can be provided. Many other models available including Servo Motors for 60 cycle duty. (Basic Type R303).

Servo Motor-Generator—The motor described above is available with an integral high performance damping generator, providing an output signal of 1/2 volt per 1000 RPM over a 5500 RPM speed range. (Basic Type 420400).

Technical Bulletins on standard Kearfott products are available and will be sent on request. Your inquiries are invited for the development and production of special units for unusual applications. Write today for Bulletin #53 describing our products and facilities.

KEARFOTT COMPONENTS INCLUDE:

Gyros, Servo Motors, Synchros, Servo and Magnetic Amplifiers, Tachometer Generators, Hermetic Rotary Seals, Aircraft Navigational Systems, and other high accuracy mechanical, electrical and electronic components.

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KEARFOTT COMPANY, INC., 1150 McBride Ave., Little Falls, N. J.
West Coast Office: 253 N. Vinedo Ave., Pasadena, Calif.
A General Precision Equipment Corporation Subsidiary



"My brushes are giving me trouble, doc—how about giving me the Stackpole treatment?"

Small Motor Brush Clinic

...for longer life, greater efficiency

No doubt, you're getting pretty good brush life and performance on small motor applications these days. *But, chances are still mighty good that they can be materially improved—at no premium cost.*

Recently, for instance, Stackpole brush developments brought about worthwhile improvement on such widely diverse equipment as toy trains, a coal drill, a d-c gas pump motor and an ac-dc inverter.

These jobs were handled the way Stackpole likes to handle them: *by getting the actual motorized equipment into our laboratories for "clinical" test.* Here, Stackpole engineers combine the greatest wealth of small motor brush "know how" in the business with carefully planned experimentation. They recognize that each brush application differs from others in essential respects. These peculiarities are taken into full account in developing grades exactly suited for the equipment in question. And, more often than not, they come up with a brush recommendation that is an improvement over what has been used in the past.



NOTE: Stackpole brushes are sold only to manufacturers of original equipment.

Write on company stationery for the 44-page Stackpole BRUSH USERS' GUIDE.

STACKPOLE CARBON COMPANY, *St. Marys, Pa.*

STACKPOLE

New Members Qualified

continued

Detroit Section

David J. Alexander (J), H. A. Berker (M), George A. Berry (J), William Harper Bickerstaff (J), George E. Brown (A), Frederick J. Burke (A), William L. Cameron (A), Carl Chakmakian (M), E. P. Carr (M), Kenneth E. Etcher (M), Louis LeRoy Grant (J), John C. Guenther (A), Marlin J. Harris, Jr. (M), Theodore R. Hoopes (A), Donald R. Hubbard (J), Steve S. Hurite (J), Milton Jovanovich (M), Carl L. Kalitta (M), Charles P. Kellett, Jr. (J), Orville Paul Kesling (J), L. L. King (M), Henry J. Lefler (J), Andrew B. MacIssac (J), George Edward Mann (M), Daniel W. McDuffee (A), Joseph Myza (A), Jarvis J. Nickrand (M), Russell R. Noble (M), Stefan Jan Nowak (A), Louis B. Peltier, Jr. (M), Charles L. Reno (M), Richard Bruce Ruokolainen (M), Capt. Chester C. Sargent (M), Clarence Arnold Sherman (M), F. E. Tayler (M), W. H. Taylor (M), William H. Taylor (A), Richard T. Thornton (M), John Paul Warrick (A), Richard George Waser (J), James L. Wheeler (A), Arthur J. White (J).

Hawaii Section

Fred L. Helbush (A), Robert R. Rex (M).

Indiana Section

Stephen Bruce Elrod (M), C. C. Hurlburt (M), Leonard B. Lisher (M).

Kansas City Section

Russel K. Rourke (M).

Mid-Continent Section

Raymond A. Jump (J), William L. Welch (J).

Metropolitan Section

Edwin Roy Ambrose (J), Thomas G. Barnes (M), Wallace E. Connolly (M), James Ernest Davis (M), Donald E. Hasbrouck (A), Nat Hellman, III (J), Carl V. Julien (A), Simm T. Jung (M), Malcolm McLoud (M), George F. Putnam (M), Paul V. Richards (M), Ross B. Skinner (J).

Mid-Michigan Section

Garnet W. Martin (M), David O. Smith (A), Henry Charles Stuerzl (M), Kenneth E. Tribell (J), Richard Fred Youngblood (J).

Continued on Page 131



CLARK

1903 1953
FIFTY YEARS
CLARK EQUIPMENT

Painstaking research, engineering experience and production skills always show up in the final product—and that's true of Clark front axles. They are known to be thoroughly dependable under trucks, busses and other industrial equipment. It's good business to work with Clark.

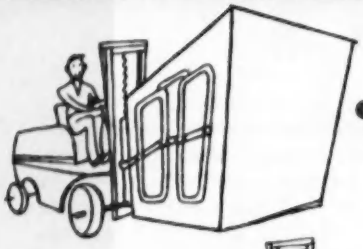
Turn and see reverse side for more about CLARK products

CLARK EQUIPMENT COMPANY, Buchanan, Michigan

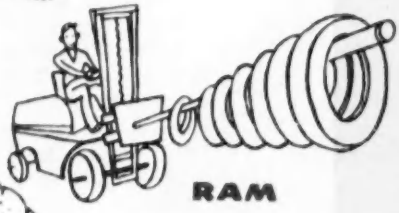
Other Plants: BATTLE CREEK AND JACKSON, MICHIGAN



Have You Explored All the Ways To Save Money With a Fork Truck?



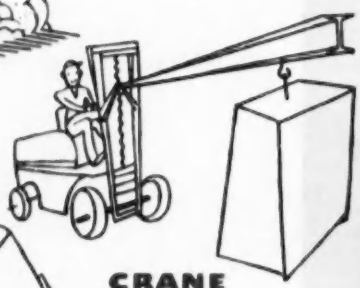
CARTON CLAMP



RAM



SHOVEL



CRANE



ROTATING ROLL CLAMP

WOULDN'T IT BE GOOD BUSINESS to know all the ways to save money with your Clark truck? It's the function of Clark attachments to transform your truck into a machine of *many* uses. Rather than let a truck stand idle for "lack of work," you can switch from one attachment to another in 10-20 minutes—go from one job to another, from partial idleness to *full-time* usefulness.

For example, why use manual labor to handle scrap, coal, sand or even cement? You'll do the job faster, more economically with one of Clark's shovel attachments. Why manhandle cartons, crates, rolls, drums, bales? Simply switch to the proper Clark attachment —there's one designed to handle practically any product or material. And for the relatively few cases where a standard attachment won't do the job, it's more than likely that our Custom Truck Department can design and build special equipment to solve the problem (—and inquiries are invited).

Perhaps you're hesitating to buy a fork truck because your principal handling job requires only part-time truck application. If that's the case, don't fail to look into this attachments angle. Chances are we've got, or can devise, one or more attachments that will enable you to utilize a fork truck profitably, all day long.

Your local Clark dealer (listed in the Yellow Pages of your phone book) will be glad to help you plan ways to multiply the usefulness of your Clark trucks and POWRWORKER hand trucks. Or write Clark Equipment Company, Industrial Truck Division, Battle Creek, Michigan, and we'll gladly send a brochure describing the Clark line of attachments.

1903 1953 CLARK EQUIPMENT

CLARK EQUIPMENT

Products — TRANSMISSIONS • AXLE HOUSINGS • TRACTOR UNITS • FORK TRUCKS and TOWING TRACTORS • ROSS CARRIERS • POWRWORKER HAND TRUCKS • POWER SHOVELS • ELECTRIC STEEL CASTINGS • GEARS and FORGINGS • FRONT and REAR AXLES for TRUCKS and BUSES

CLARK EQUIPMENT COMPANY, BUCHANAN, MICHIGAN

OTHER PLANTS: BENTON HARBOR • BATTLE CREEK and JACKSON, MICHIGAN

New Members Qualified

continued

Milwaukee Section

Allen W. Church (M), Gilbert H. Johnson (A), Verne W. Nichols (A), Raymond E. Paul (M).

Mohawk-Hudson Group

Charles Forsyth Hastie (J), William R. Higgins (M), Ernest E. Johnson, Jr. (M), Alan Lee Williamson (J).

Montreal Section

Ronald J. Baker (M), Hugh Graham Brown (A), R. J. Di Cicco (J), Lionel (Leo) Renaud (A), William Grey Scherk (M), Thomas Joseph Stringer (M), John Tristram (M).

New England Section

Theodore F. Andren (A), William B. Greeley (J), Angelo F. Lucadamo (M), Jack R. Martin (J), Frank Edward Wahlen (M), A. F. Wiegand (J).

Northern California Section

E. I. Brajenovich (J), F. A. M. Buck (M), Russell Emmett Fahey (J), William B. Gripe (J), Charles Keith Parker, Jr. (M), Edward H. Parkhurst (M), Marcus W. Savage (M), Lawrence R. Sullivan (M).

Oregon Section

John L. Kruse (J), Jacques M. Long (M), William Adam Simpson (A), Theodore "Ted" Ernest Smirl (M), Charles Patrick Van Winkle (A), Milton E. Winters (A).

Philadelphia Section

William T. Beaver (M), William G. Beyer (J), Arthur Fuerman (J), Morton Jacobson (M), Frederick Babbidge Lee (M), Albert L. Lockwood (J), W. Raymond Van Vechten (A), Benjamin Wayne Watson (M).

Pittsburgh Section

Lt. (jg) Robert Miller Kuhn (J).

St. Louis Section

Joseph Claude Anderson (A), Charles J. Dinter, Jr. (A).

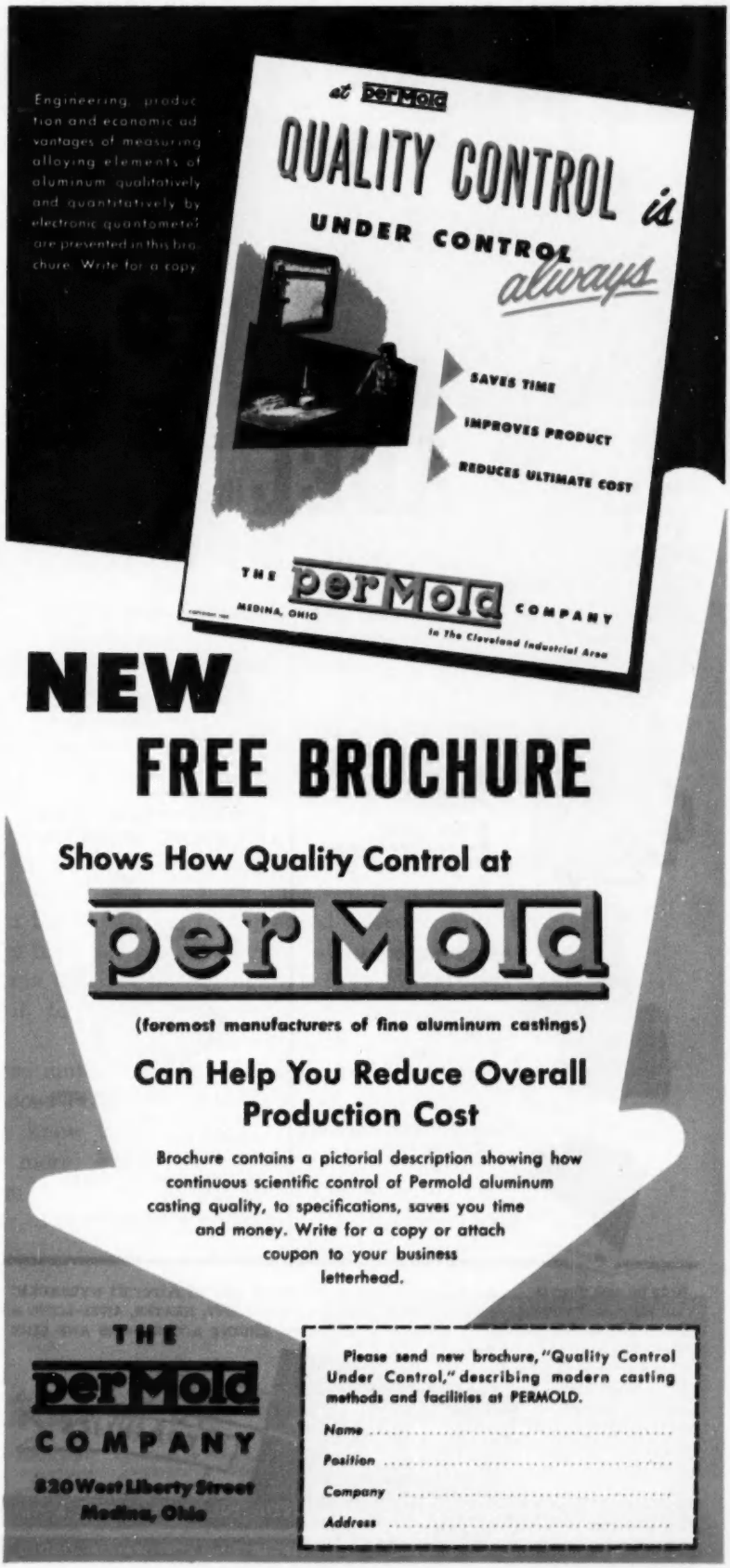
Salt Lake Group

Frederick J. Blatz, Jr. (J), J. D Lawson (M).

San Diego Section

Chandos L. Jackson (M), Joseph F. Schirtzinger (M).

Continued on Page 132





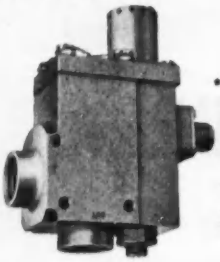
ADEL Hydraulic

SHUT OFF VALVES

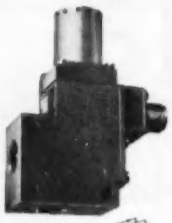
(Solenoid Operated)

PRODUCED TO RIGID AIRCRAFT STANDARDS

26038 WITH INTEGRAL RELIEF. NORMALLY CLOSED.
¼" and ⅜" LINE SIZES.
Operating pressure: 350 psi; Relieves inlet to outlet within 500 to 700 psi range.
Weight: 0.60 lb.
(Also available in 1500 and 3000 psi capacities.)



*25853 PILOT OPERATED. NORMALLY CLOSED.
⅜" and ½" LINE SIZES.
Operating pressure: 3000 psi.
Weight: 1.45 lb.
(Also available with manual override or normally open.)

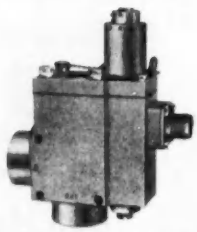


*26610 PILOT OPERATED. NORMALLY OPEN.
¼" and ⅜" LINE SIZES.
Operating pressure: 3000 psi.
Weight: 0.81 lb.
(Also available normally closed.)



*High Flow Capacity Valve with filtered pilot circuit.

FLUID: Specs. MIL-O-5606 or MIL-F-7083.
ELECTRICAL RANGE: 18-30 VDC.
SOLENOID DUTY: Continuous.
CURRENT DRAIN: 0.5 Amp at 24 VDC.
TEMPERATURE RANGE: −65°F to +250°F.
LIGHTWEIGHT, COMPACT, CORROSION RESISTANT CONSTRUCTION.



*25670 PILOT OPERATED. WITH MANUAL OVERRIDE. NORMALLY CLOSED.
¾" and ⅜" LINE SIZES.
Operating pressure: 3000 psi.
Weight: 1.58 lb.
(Also available normally open without manual override.)

Write for new, descriptive Brochure containing detailed information on ADEL's line of Aircraft Equipment and facilities. Address ADEL DIVISION, GENERAL METALS CORPORATION, 10783 Van Owen St., Burbank, Calif.

ADEL produces a complete line of Aircraft HYDRAULIC & PNEUMATIC CONTROL EQUIPMENT, HEATER, ANTI-ICING & FUEL SYSTEM EQUIPMENT, ENGINE ACCESSORIES AND LINE SUPPORTS.

ADEL LEADER IN HYDRAULICS

DIVISION OF GENERAL METALS CORPORATION • BURBANK, CALIF. • HUNTINGTON, W. VA.

CANADIAN REPRESENTATIVE: RAILWAY & POWER ENGINEERING CORPORATION, LIMITED

New Members Qualified

continued

Southern California Section

Otto Erich Balje (M), Frances Gaba Gorman (A), James F. Hayward (M), Albert L. Hess (A), Philip W. McLane (M), Charles William Thrift (J), Ivan J. Umbarger (M), R. A. Wagner (M), Eldon M. Wilson (M), Allen Soong Yaplee (J).

Southern New England Section

Donald Harris Amidon (M), John O. Emmerson (M), Thomas H. Johnston, Jr. (A), Edward D. Kane (J), Donald R. Olson (M), James A. Taylor (M).

Spokane Intermountain Section

M. F. Rice (M).

Texas Section

Walter Gladson (A), Clifford F. Holcombe (A), George C. Lawrason (M), J. C. Tatum (A).

Texas Gulf Coast Section

James M. Adams (A), Ben F. Denny (A).

Twin City Section

Orval Edward Lorenz (A), Lester A. Wilsey, Jr. (A).

Virginia Section

Robert Clinton Seavers, Jr. (A).

Washington Section

Robert J. Auburn (M), Major Kidar Nath Koshal (M), Norman C. Witbeck (M).

Wichita Section

Lewis A. Paul (M).

Williamsport Group

Wade O. Hemphill (M).

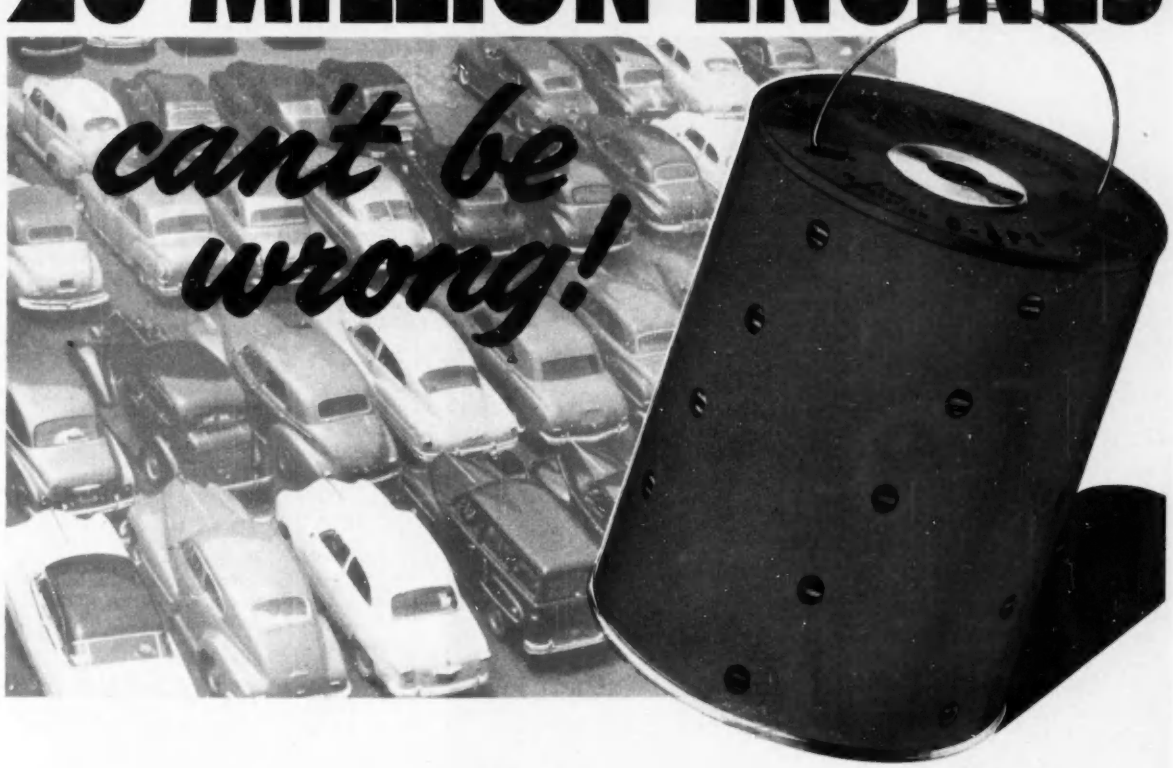
Outside Section Territory

Samuel Gadeski (A), Ensign David Walter Knoll (J), Melvin Maurice Moncel (M), James L. Smith (M), Teddy Russell Stauffer (A), Robert Tetrault (M), George N. Turner (A), Ernest D. Vernon, Jr. (J).

Foreign

Arthur St. John Mitchell (A), England; Alan Colin CampbellOrde (M), England; Paul Henri Perrot (M), France.

20 MILLION ENGINES



OVER THE YEARS, millions of cars, trucks, tractors and buses have been factory-equipped with Fram Filters. In addition, millions of vehicles have been equipped with Fram products by their owners—bringing the total to more than 20 million engines!

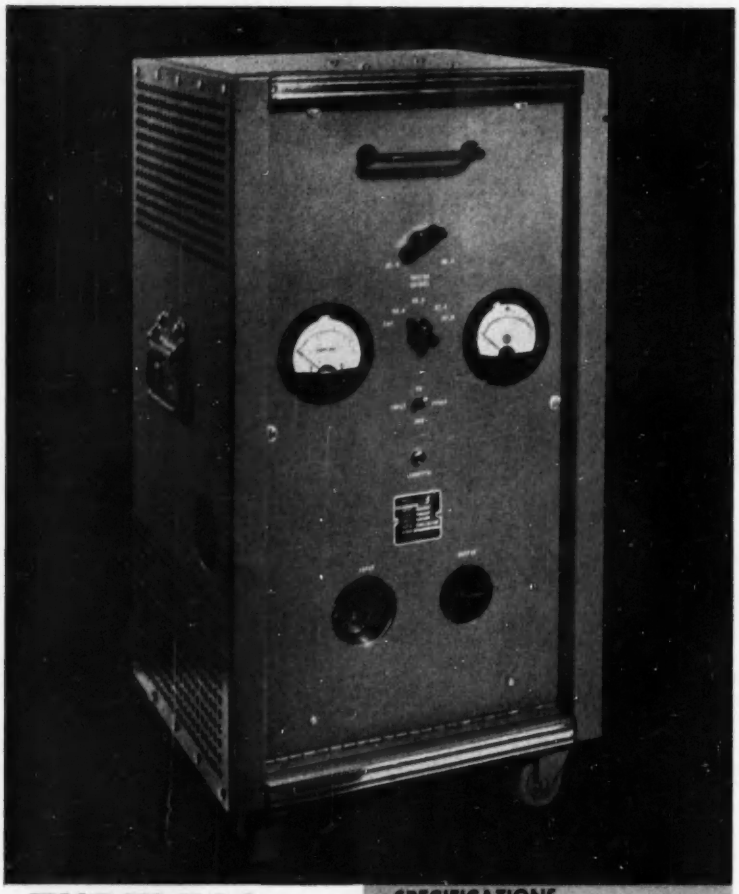
There's a reason why more motorists and manufacturers alike choose FRAM over all other filters. They know that *FRAM filters best!* What's more, only Fram offers Complete Engine Protection with a full line of Oil, Air, Fuel and Water Filters.

Fram's widespread manufacturing facilities offer you high-speed production and top-speed delivery. And the Manufacturers Sales Division in Dexter, Michigan, is fully staffed to provide the automotive industry with fullest cooperation in meeting any and all types of filtration requirements. For complete information, write, wire or phone FRAM CORPORATION, Providence 16, R. I. *Plants in;* Pawtucket, R. I.; Greenville, Ohio; Jacksonville, Fla.; Brigham City, Utah. *In Canada:* FRAM CANADA LIMITED, Stratford, Ontario.

Manufacturers of...

FRAM OIL & MOTOR CLEANERS ★ FRAM FILCRON REPLACEMENT CARTRIDGES ★ FRAM CEL-PAK REPLACEMENT CARTRIDGES ★ FRAM FILTRONIC REPLACEMENT CARTRIDGES ★ FRAM CARBURETOR AIR FILTERS ★ FRAM GASOLINE FILTERS ★ FRAM CRANKCASE AIR FILTERS ★ FRAM POSITIVE CRANKCASE VENTILATORS ★ FRAM RADIATOR & WATER FILTERS ★ FRAM FUEL OIL FILTERS ★ FRAM INDUSTRIAL OIL AND FUEL FILTERS ★ FRAM SEPARATOR-FILTER FOR IMMISCIBLE LIQUIDS ★ FRAM CUSTOM-DESIGNED FILTERS FOR SPECIALIZED APPLICATIONS.

FRAM
OIL • AIR • FUEL • WATER
FILTERS



TUBELESS MAGNETIC AMPLIFIER DC SUPPLIES

for Automotive and Aircraft Industries

Sorensen Nobatrons Model MA6/15 and Model MA2850 are tubeless — using magnetic amplifier principles. They have plenty of current capacity — 100 amps at 6 volts or 75 amps at 12 volts in the MA6/15 and 50 amps at 28 volts in the MA2850. Please see the specs below.

The MA6/15 is designed primarily as an automotive production test instrument for use in checking window motors, heaters, clocks, radios, headlight dimmers, ignition systems, air conditioners, cigarette lighters. The MA2850 can be used for testing aircraft heaters, pitch changers, inverters, radar, fire control systems, etc. Built around tubeless circuits, both models are carefully engineered and built to give you years of trouble-free, dependable service. Write for information now!

SPECIFICATIONS

Model MA2850

Input voltage range	190-230, 3ϕ, 4 wire, 60~ .
Output	28 volts DC, adjustable between 23 and 36 volts.
Current	0 - 50 amperes
Ripple	3% max RMS
Regulation accuracy	±1% against line and load combined
Time constant	0.5 seconds under worst conditions
Dimensions	15½" wide x 25⅜" high x 13" deep

Meters are standard. Units are self contained.

Model MA6/15

Input voltage range	210-250 VAC, 1ϕ, 60~ .
Output	Adjustable 6 - 7.7 volts DC from 0-100 amperes Adjustable 12 - 15.4 volts DC from 0-75 amperes
Ripple	1% max RMS
Regulation accuracy	±1% against line and load combined
Time constant	0.2 seconds under worst conditions
Dimensions	21" wide x 36" high x 15" deep

Meters are standard. Cabinets optional.

SORENSEN

Sorensen and Company • 375 Fairfield Ave. Stamford 89, Conn.

Applications Received

The applications for membership received between July 10, 1953 and August 10, 1953 are listed below.

British Columbia Section

George Edward Clark.

Buffalo Section

Lawrence C. Dermond, Pandeli Durbetaki.

Canadian Section

Avrom A. Buck, Gordon S. Manser, Frederick Irvin Musselman, Thomas Albert Peake, William George Richardson.

Chicago Section

George Richard Armstrong, Robert C. Landesman, William L. Steinhoff, Carl F. Herschbach.

Cincinnati Section

J. Donald Cleavinger, Charles Robert Plum.

Cleveland Section

Harry C. Graham, John Philip McSweeney, Robert L. Perry, Thomas Wilson Thoburn, Jr., Richard K. Brown.

Detroit Section

Walter E. Aring, John Gibbard Badenhope, Gerald R. Bouwkamp, William Joseph Breitenbeck, Keith Graham Burkitt, Paul B. Carle, Franklin E. Carr, Maurice E. Compton, Charles C. Conley, Don Dence, Carl R. Fraser, E. W. Gentz, Raymond J. Haefner, Kenneth H. Higgins, Robert Charles Holan, John W. Ingrody, Robert A. Kamenec, Frank A. Kunze, T. Harold Lindholm, Walter R. Mackenzie, Wayne A. Martin, Hugh J. McNichol, Jr., Robert Montgomery, Hermann D. Mysing, Leroy Polenz, Vincent Louis Polkus, George P. Ransom, Elmer Rushak, Edward B. Ryan, Nathan Norman Shiovitz, Robert B. Singer, Daniel H. Spurlin, Paul W. Stuehn, Walter E. Thomas, Robert J. Tilley, John R. Miller, Edward A. Tubbs.

Hawaii Section

Herbert Gordon Gardiner, Farnham J. Johnson.

Indiana Section

William Woodrow Barton, Eugene S. Murphy.

Kansas City Section

Robert E. Adel, Major James W. Kelly.

Metropolitan Section

Edward S. Clark, Henry Austin Clark, Jr., Timothy F. Donovan, Wesley T. Dorsheimer, Alvin M. Fischer, Leonard N. Flomerfelt, Jr., Arthur L. Lawrence, George Horning Lowden, Leonard J. Nowikowski, J. J. McCarthy.

Continued on Page 136

NEW HEATER-DEFROSTER

SMALLER IN SIZE ...BIGGER IN OUTPUT!

SMALL
only 8-1 16" x 8-5 16" x 8-3 8"

POWERFUL
17,800 BTU Output

EFFICIENT
split core and tank travel water further — heat lingers longer

HEAVY DUTY
"Continuous service" bus type motor — heavy duty truck service core

ADAPTABLE FOR RECIRCULATING OR FRESH AIR
Simple to connect to top or side cowl for fresh air intake



The new EVANS ED-75

Provides more heat output than any other heater-defroster of its size

Each Evans unit is custom engineered for its specific vehicle installation, to provide a completely satisfactory heating and ventilating system. Evans units are available for a wide variety of commercial vehicle applications.

The Evans organization is staffed to engineer units to specification, organized to build prototypes quickly, equipped to conduct precision tests to latest A.S.H.V.E. procedures. Military experience dating back to World War I qualifies Evans to work with you in meeting the rigid specifications of the Armed Forces. If your needs are for high performance, ruggedly constructed equipment—it will pay you to consult Evans Products Company, Heating & Ventilating Division, Dept. Z-9, Plymouth, Mich.

EVERY EVANS HEATER IS EQUIPPED WITH THE FAMOUS EVANS UNBREAKABLE LIGHTWEIGHT FAN

Precision die-molded airfoil section blades . . . move *more* air with *less* noise and current draw . . . will not chip, crack or bend . . . unaffected by temperature . . . one piece construction.



EVANS ... BALANCED HEATING & VENTILATING **CUSTOM HEATERS** ... FOR EVERY TRUCK AND BUS

EVANS



Don't Worry About Nuts In Hard-To-Get-At Places

use

MIDLAND

Welding Nuts

THIS IS ALL YOU DO—Just insert collar of Midland Welding Nut in hole for bolt or screw, resistance weld the Nut in place, and the *nut is there for the life of the job.* Nuts can be automatically fed to the welder. No time wasted or trouble screwing-on nuts in hard-to-get-at places. Write for facts about these better connections at *less cost.*

The MIDLAND STEEL PRODUCTS COMPANY

6660 Mt. Elliott Ave. • Detroit 11, Michigan

Export Department: 38 Pearl St., New York, N. Y.

Manufacturers of

AUTOMOBILE AND TRUCK FRAMES | AIR AND VACUUM POWER BRAKES | AIR AND ELECTRO-PNEUMATIC DOOR CONTROLS

Applications Received

continued

Mid-Continent Section
William Walter Merryman, Clarence A. Neilson.

Mid-Michigan Section
Burton Aloit Fierstine, Dulaney D. Smith.

Milwaukee Section
Alan R. Kishline, Donald Eugene Peterson, Carl Otten Trautmann, Alfred E. Berg, H. Ward Olander.

Mohawk-Hudson Group
Sherman Crane Kent.

Montreal Section
Paul Edward Falkner, Jean Guy Gadoua.

New England Section
Harvey G. Clauson, Jr., Walter Hume Renear.

Northern California Section
John Y. H. Ahn, Bobby W. Malone, Glen P. McGraw, William James Wood.

Northwest Section
Russel S. Adams, C. M. Riddell.

Pittsburgh Section
Michael J. Amoroso, Robert C. Barker.

St. Louis Section
John F. Wickey.

Salt Lake Group
Ross W. Eskelson.

San Diego Section
A. F. Kitchin, Don Durnal.

Southern California Section
George O. Abell, Martin Sherman Blackman, James Clifton Glass, Louis Y. Kado, Leonard W. Lewandowski, Luciano F. Molinari, Henry DeWain Spiekerman, George A. Starbird, Kilbourne H. Knox.

Southern New England Section
Allen Edward Cable, Edward F. Wilk.

Syracuse Section
William A. Uline.

Texas Section
Herbert M. Gaebe, Thomad D. Hughston, Jr., Henry J. Korp, James Barry Temple.

Twin City Section
Hardy G. Reynolds, Jr.

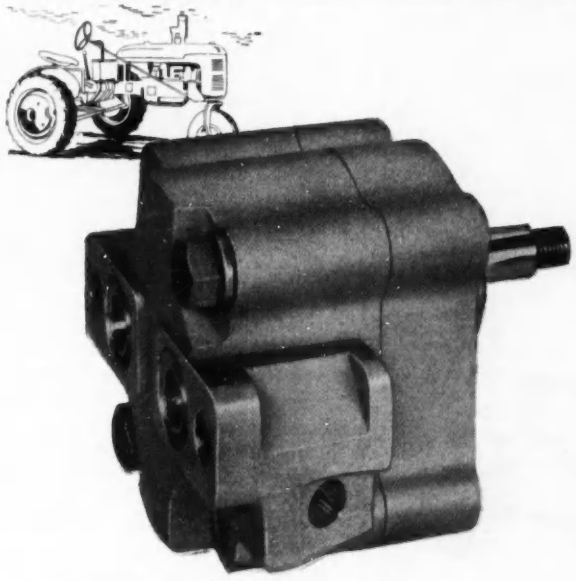
Outside of Section Territory
Robert Morrison Aldwinckle, Ramon Dahyabhai Amin, Joyce S. Bailey, Jack H. Hobson, Donald S. Perry, Kenneth Oliver Robinson.

Foreign
Charles Stanhope Lyttleton Frances, Ceylon; Julius Liebel, Germany; Charles Kearns Edwards, England.



This Thompson power steering pump for use in automotive power steering systems, is an internal gear pump with a more uniform flow, better distribution of driving pressure, and improved operating efficiencies. Among other outstanding features of this Thompson-engineered pump are quiet operation, flat flow control characteristics, combination flow control and relief valve, and competitive manufacturing cost.

Pump performance you can take for granted



Thompson's hydraulic pump used to actuate tractor implements features pressure loaded end plates, which compensate for wear and results in longer service life. This farm implement pump has a high discharge pressure—1200 P.S.I.—and high volumetric and overall efficiencies.

WHETHER it's a farm implement pump or a power steering pump, you can depend on Thompson for precision engineered pump performance.

Techniques and skills gained in manufacturing complex items, many with the closest tolerances, are applied to Thompson pumps—assuring maximum performance and dependability.

In addition to these pumps to actuate your farm implements and for use in your power steering system, Thompson also manufactures industrial pumps. Our engineers will gladly work with you to design pumps for your specific application. Write, wire or phone, Special Products Division, Thompson Products, Inc., 2196 Clarkwood Road, Cleveland 3, Ohio.

You can count on

Thompson Products

SPECIAL PRODUCTS DIVISION



BURBANK, CALIFORNIA 233 South Third Street
DALLAS, TEXAS 413 Fidelity Union Life Building
PHILADELPHIA 7, PENNSYLVANIA 725 Widener Building
DAYTON 2, OHIO 410 West First Street
DETROIT 2, MICHIGAN 311 Curtis Building
NEW YORK 16, NEW YORK 280 Madison Avenue
CHICAGO 11, ILLINOIS 520 N. Michigan Ave.
CLEVELAND 15, OHIO Room 811, Hanna Building

LORD MANUFACTURING COMPANY • ERIE, PA.

LORD BONDED RUBBER

Headquarters for
VIBRATION CONTROL

Advertisement

Lord Bonded-Rubber Products Set Standard In Vibration and Shock Control For Over Twenty-Five Years

In the field of technical analysis and engineering to "design out" destructive factors set up in the machines of industry by vibration and shock, Lord Manufacturing Company continues to pioneer and set the pace for precision made vibration control mountings and bonded-rubber parts.

Years of experience in mounting aircraft engines and airframe components enable Lord Engineers to help industrial equipment designers in obtaining smoother operation, longer service life and increased safety in their machines.

Lord Engineers draw from some 27,000 basic designs and their variations to solve many vibration and shock problems referred to them by machine designers. Add to this the continuous research engineering available from the company's complete laboratories, and it becomes a matter of near impossibility to present a vibration problem which cannot find soluton in the Lord Organization. The scope of Lord Design and Precision Manufacture covers Vibration Control Mountings for aircraft engines and components in both the internal combustion and jet field, delicately balanced and precisely assembled units of accounting machines, electronic equipment, instrument panel mountings, shipping case mountings for the protection of sensitive machines in transit.

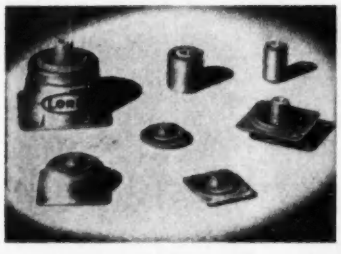
Designers of home appliances use Lord bonded-rubber parts for fan-hubs, flexible couplings and special components for washing machines, room air conditioners, mixing and juicing devices. Lord Flexible Couplings are used in the mechanism which operates motorcar windows and convertible tops. The turbine engine for heavy duty motor truck transport, a recent development of the Boeing Airplane Company, is connected to the power transmission by a special Lord Flexible Coupling and the engine itself is supported on Lord Mounts. Lord Engineering and Precision Manufacturing facilities are available to business and industry wherever Vibration and Shock Isolation problems require a precise, accurate and inexpensive solution.

Advertisement

Lord Vibration Control Mountings . . . The Most Effective Protection For Electronic Equipment

In the rapidly advancing field of electronics, the control of destructive vibration and isolation of damaging shock are prime factors in the consideration of design engineers. Lord, Headquarters for Vibration Control, is constantly working with electronics engineers to improve the methods for protecting sensitive mechanisms.

For instance, Varo Static Converters which change alternating to direct current for aircraft with less than 1% voltage ripple are protected against shock and vibration by Lord Mountings. High fidelity Audio frequency electronic equipment such as Collins Radio Company manufactures is protected from vibration and shock through the use of Lord Mountings. The 212A-1 Broadcast Station Speech Input Console by Collins requires 28 Lord square Plate Form Mountings to protect each amplifier stage individually. This prevents mechanical interaction between stages and lessens acoustical feed-back effects.



Again the Agnew Spark Plug Welder by Agnew Electric Company uses Lord Mountings to support the electronic weld timers to prolong the useful service life of Mercury Vapor Tubes.

Lord Mountings, which you see illustrated in the accompanying advertisement, are used in a wide diversity of applications to protect electronic equipment and sensitive instruments. Business machines and such sensitive mechanisms, the accuracy of which must be perfect, are improved in operation and protected from damaging vibration and shock by Lord Mountings.

The Lord Manufacturing Company, Erie, Pa., offers a vast reservoir of recorded experience in the solution of vibration and shock problems. Your request for help on your own problem is welcomed.

LORD MOUNTINGS PROTECT INSTRUMENTS *and* ELECTRONIC EQUIPMENT *from* VIBRATION *and* SHOCK DAMAGE • • •



VIBRATION and shock are natural enemies of electronic equipment and precision instruments . . . To control the damage which these enemies can do, Lord Vibration Control Mountings and Bonded Rubber Parts are used to very profitable advantage. More than a quarter century's experience in dealing with vibration and shock is yours when you take advantage of Lord engineering assistance. The result of such consultation is full protection for electronic units and sensitive instruments by correctly designed and precisely manufactured Lord Mountings and Bonded-Rubber parts.

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DALLAS, TEXAS 413 Fidelity Union Life Building
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NEW YORK 16, NEW YORK 280 Madison Avenue
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CLEVELAND 15, OHIO

LORD MANUFACTURING COMPANY • ERIE, PA.

LORD BONDED RUBBER

Headquarters for VIBRATION CONTROL

McQUAY-NORRIS

PISTON RINGS



Manufacturers have recognized the
engineering and production skills
of McQuay-Norris in the piston ring
field for more than 40 years.
For Piston rings to meet every requirement
— no matter how exacting —
our engineering know-how is at your disposal.

McQUAY-NORRIS
LEAK-PROOF
PISTON
RINGS
FOR YOUR CAR

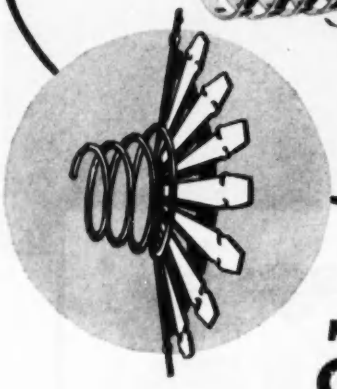
McQUAY-NORRIS MFG. CO. • ST. LOUIS 10, MO.

the SOFT Acting CLUTCH with the *Sure Grip*

...Just like a hand of Steel in a Velvet Glove



The hand of steel in the Lipe Clutch has 20 fingers that equalize the pressure of a single spring—assuring softer engagement and a positive grip.



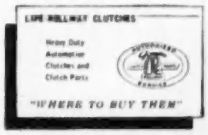
LIPE MULTI-LEVER CLUTCH

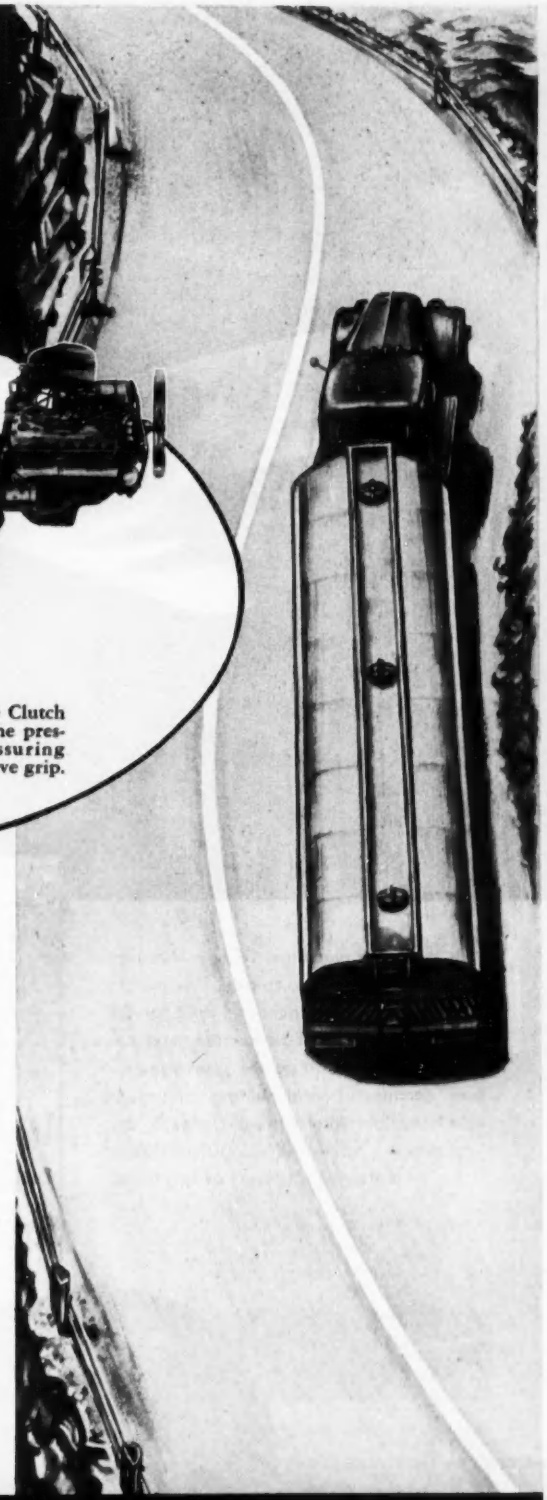
Lipe's soft engagement, positive grip Multi-Lever Clutch never needs babying. It engages smoothly—without grab, shock or jerk. All parts of the pressure plate touch at the same instant with the same pressure. No cocking—no point of high slippage and spot burning.

Result: More mileage between tear-downs.

Write for Service Manual and complete data on genuine Lipe parts—stocked in principal cities.

For quick service on genuine Lipe parts, look for this ad in the yellow pages of the telephone directory in principal cities.





LIPE ROLLWAY

Lipe-ROLLWAY CORPORATION

Manufacturers of Automotive Clutches and Machine Tools

Syracuse 1, N. Y.



Here's the big, handsome, DC-7 — Douglas' latest commercial airplane. This picture shows off the power packages built for the DC-7 by Rohr... world's largest producer of ready-to-install power packages for both commercial and military planes. In addition, Rohr Aircraftsmen currently are producing more than 25,000 different parts for all types of airplanes.

power packages by

ROHR



WORLD'S LARGEST PRODUCER OF READY-TO-INSTALL POWER PACKAGES FOR AIRPLANES

ROHR
AIRCRAFT CORPORATION

CHULA VISTA AND RIVERSIDE CALIFORNIA

6



Our modern plants

in six separate locations

give you a stabilized, dependable

source for sleeve bearings

and bushings—



and the finest engineering and

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CHICAGO
McCormick Bldg. • WAbash 2-6220

The Cleveland Graphite Bronze Company

DIVISION OF CLEVITE CORPORATION

Are retained lubrication and long bearing life vital?

here's how leading harvesting machine manufacturers secure them with NEEDLE BEARINGS

Torrington Needle Bearings are important design features on many harvesting machines because of their unique ability to retain lubricants, and because of their long service life.

They have been *performance-proved* in machines which handle a wide variety of crops, on every type of soil and terrain—including combines, corn or cotton pickers, mowers and other miscellaneous harvesting equipment.

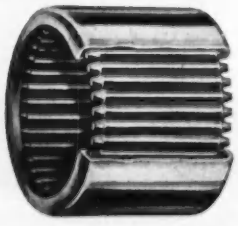
Needle Bearings in such machines are found in main drives, gearboxes, crankshafts, bell cranks, idler pulleys, sprockets, steering gears and various linkages. The small but rugged Needle Bearing has capacity for long life under punishing loads and severe operating conditions always present in the use of such equipment. Furthermore, the turned-in lips of the Needle Bearing's outer shell retain lubricants for long periods—reducing down time for relubrication to a minimum.

Needle Bearings have become "standard equipment" throughout industry since their introduction nearly twenty years ago. Their low cost, small size, and ease of installation make them the natural choice for increasing numbers of anti-friction applications.

Torrington Needle Bearings may offer a solution to your bearing problems. Our engineers will be glad to help you find out.

THE TORRINGTON COMPANY
Torrington, Conn. • South Bend 21, Ind.



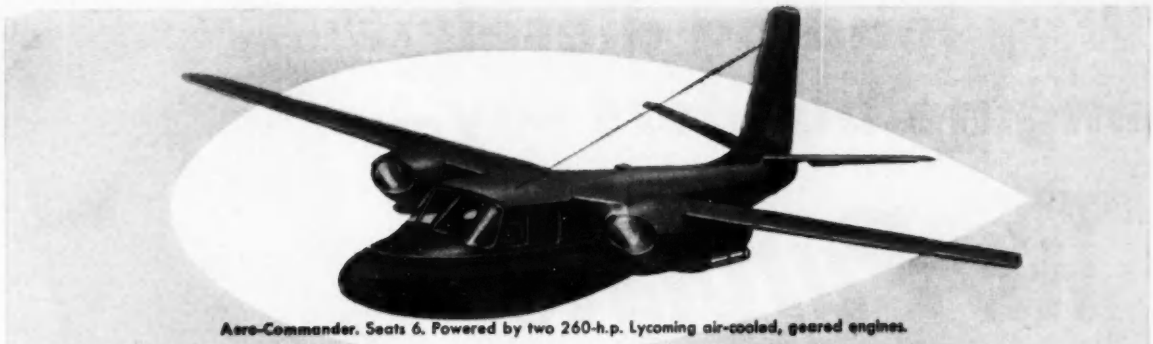


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Grumman Widgeon Conversion. Amphibious flying "office" featuring 260-h.p. air-cooled, geared engines by Lycoming.

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You are now looking at the "wings" carrying America into a great new era of safe, economical executive transportation. Each of these twin-engine, multi-passenger planes is powered by Lycoming . . . long a leader in the up-to-500-h.p. engine field. Each has the double dependability of *two* air-cooled Lycoming engines—so powerful that the planes can safely fly and land with a full load *on one engine alone.*

To fly any time, any place . . . these are the safest "offices" *over* earth . . . the soundest investments in executive aircraft *on* earth. *For further information, write us on your letterhead.*

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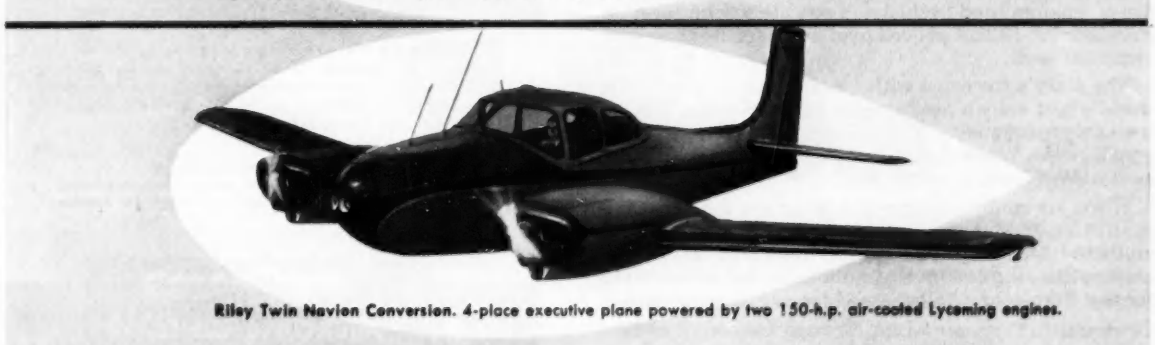
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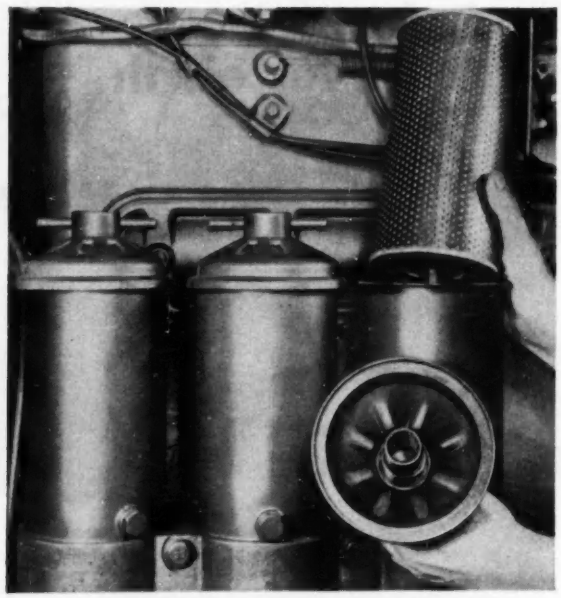
Riley Twin Navion Conversion. 4-place executive plane powered by two 150-h.p. air-cooled Lycoming engines.

Why leading diesel engine builders say—

It's *Purolator** for Full-Flow!



- **Full-flow rates within practical filter dimensions:** Purolator's famous "accordion-pleated" Micronic* filter element has up to ten times more filtering area than old-style filters—gives high flow rates in a minimum of space.
- **Ultra-micronic filtration:** High flow rates are, of course, meaningless unless effective filtration is maintained, too. Electron micrographs prove that the Purolator Micronic filter stops particles down to *submicrons*—.0000039 in.!
- **Maximum dirt storage capacity:** The pleated design of the Micronic filter element provides many times more dirt storage space than old-style filters. This important advantage means uniform, efficient performance and a lengthy service life.
- **Minimum pressure drop:** The Purolator Micronic filter element introduces a remarkably small pressure drop in the lubricating system . . . permitting pumps of practical size and simple type.
- **Will not remove or absorb additives:** With Purolator Micronic filtration, you keep *all* the oil quality you pay for. The Micronic filter element will not strip additives . . . an important advantage with HD and heat-resistant oils



Purolator Micronic Filters in a typical Diesel full-flow installation. Although the Purolator Micronic filter elements measure only 4½ in. by 9 in., *each one filters 9 gallons of oil per minute*, giving a total of 27 g.p.m. for the complete filter unit.

Modern engines with full-flow lube systems . . . which filter *all* the oil at each pass through the engine . . . demand the best in filters. And most leading makers of diesel engines and vehicles agree that the best is *Purolator** . . . a fact proved over and over by their own impartial tests.

The story's the same with gasoline engines, too! The world's best known producers of passenger cars, trucks, tractors, earth-moving equipment, and stationary engines have found Purolators best . . . and install them as standard factory equipment.

If you are contemplating new designs or modifications of existing ones, remember . . . there's a well-engineered and use-tested Purolator for *any* filter application, including fuel oil, gasoline, hydraulic fluid, and water. Write for the Purolator catalog issued for your special field.

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1. No gear splitting—10 selective gear ratios, evenly and progressively spaced. **2.** Easier, quicker shifts—28% steps—one shift lever controls all 10 forward speeds. **3.** Higher average road speed—engine operates in peak hp range with greater fuel economy. **4.** Less driver fatigue—*i. e.* less shifting. **5.** Range shifts pre-selected—automatic and synchronized. **6.** More compact than other 10-speeds. **7.** More cargo on payload axle.

Available in Models R-95-C and R-950-C (overdrive)

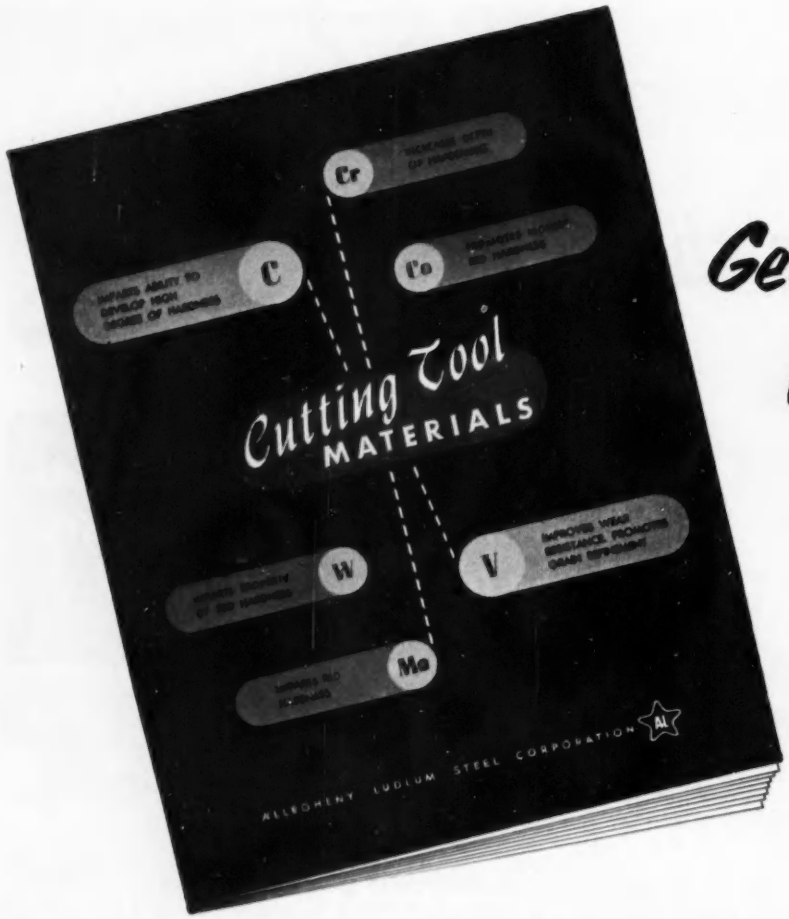


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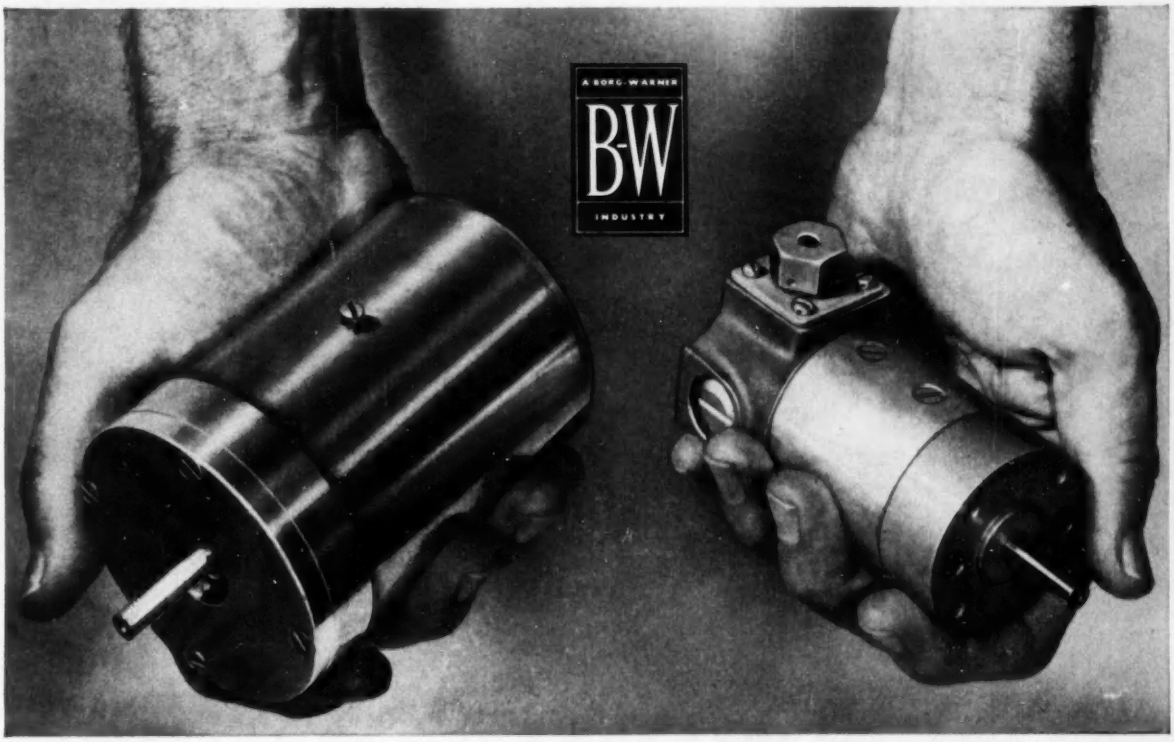
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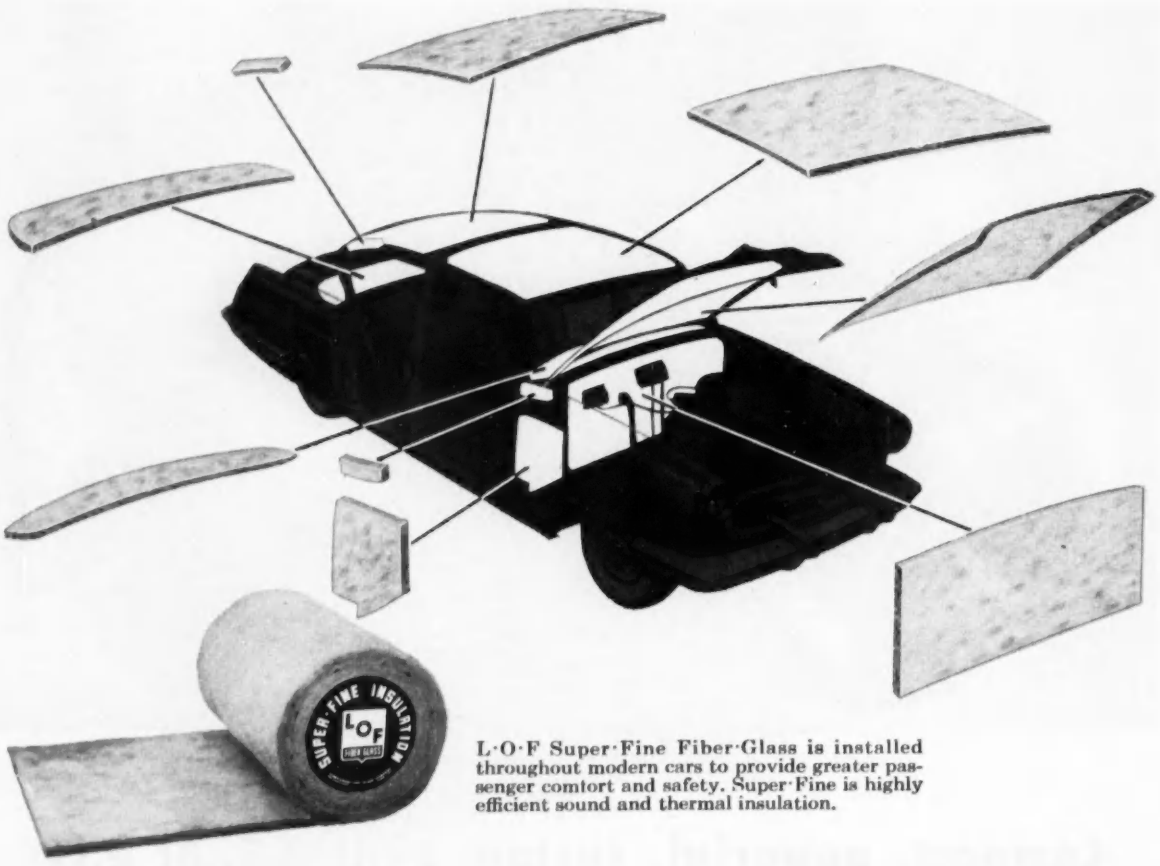
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The successful effort to quiet an engine begins with attention to moving parts, and ends with a blanket of L·O·F Super·Fine Fiber·Glass installed under the hood and on the fire wall. There are few owner satisfactions to compare with an engine that never speaks above a whisper.

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For further information, call L·O·F's Detroit office, 610 Fisher Building, TRinity 5-0080. Or write us for the names of Hoodliner-Kit suppliers. Libbey·Owens·Ford Glass Co., Fiber·Glass Division, 693 Wayne Building, Toledo 3, Ohio.

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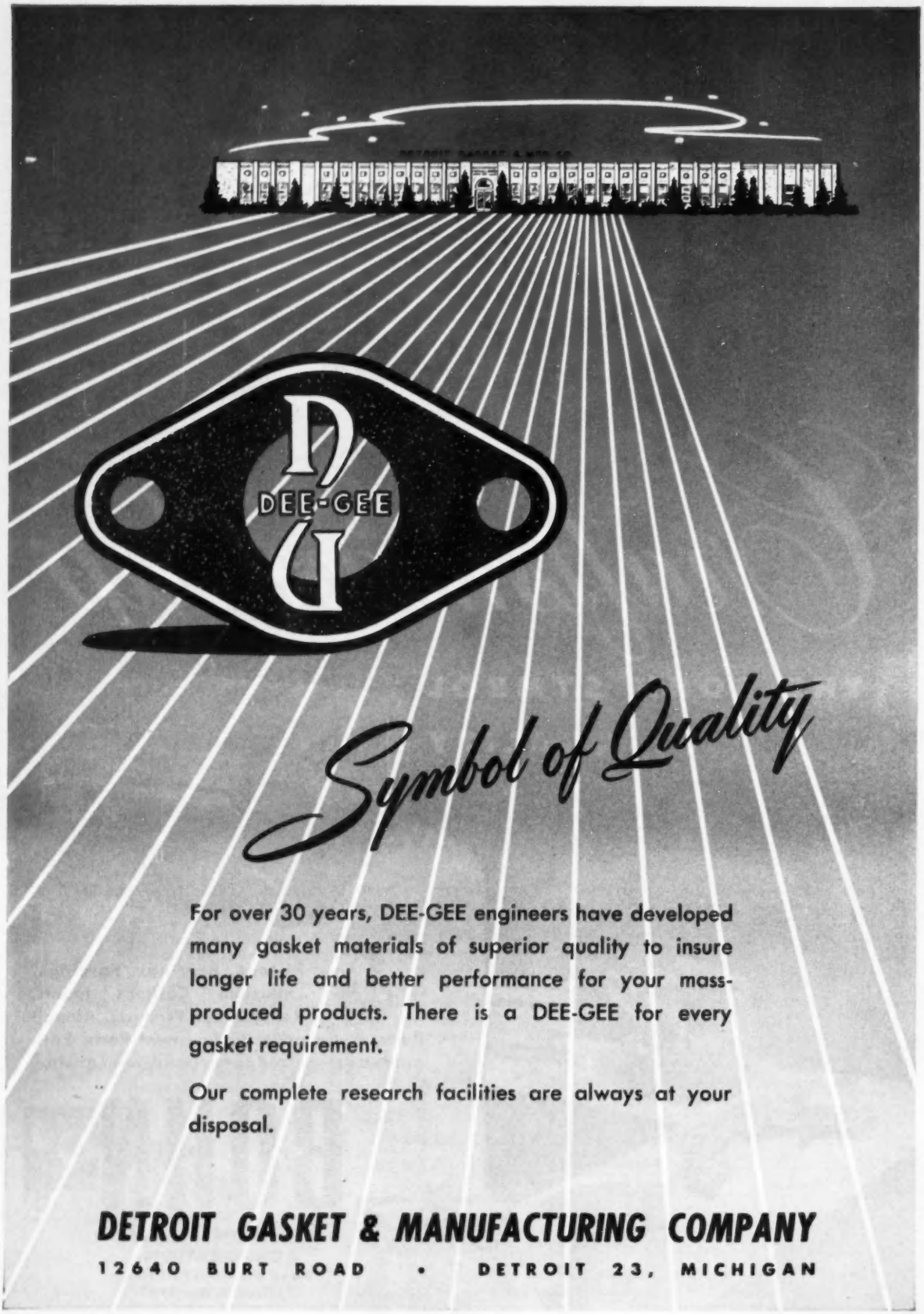


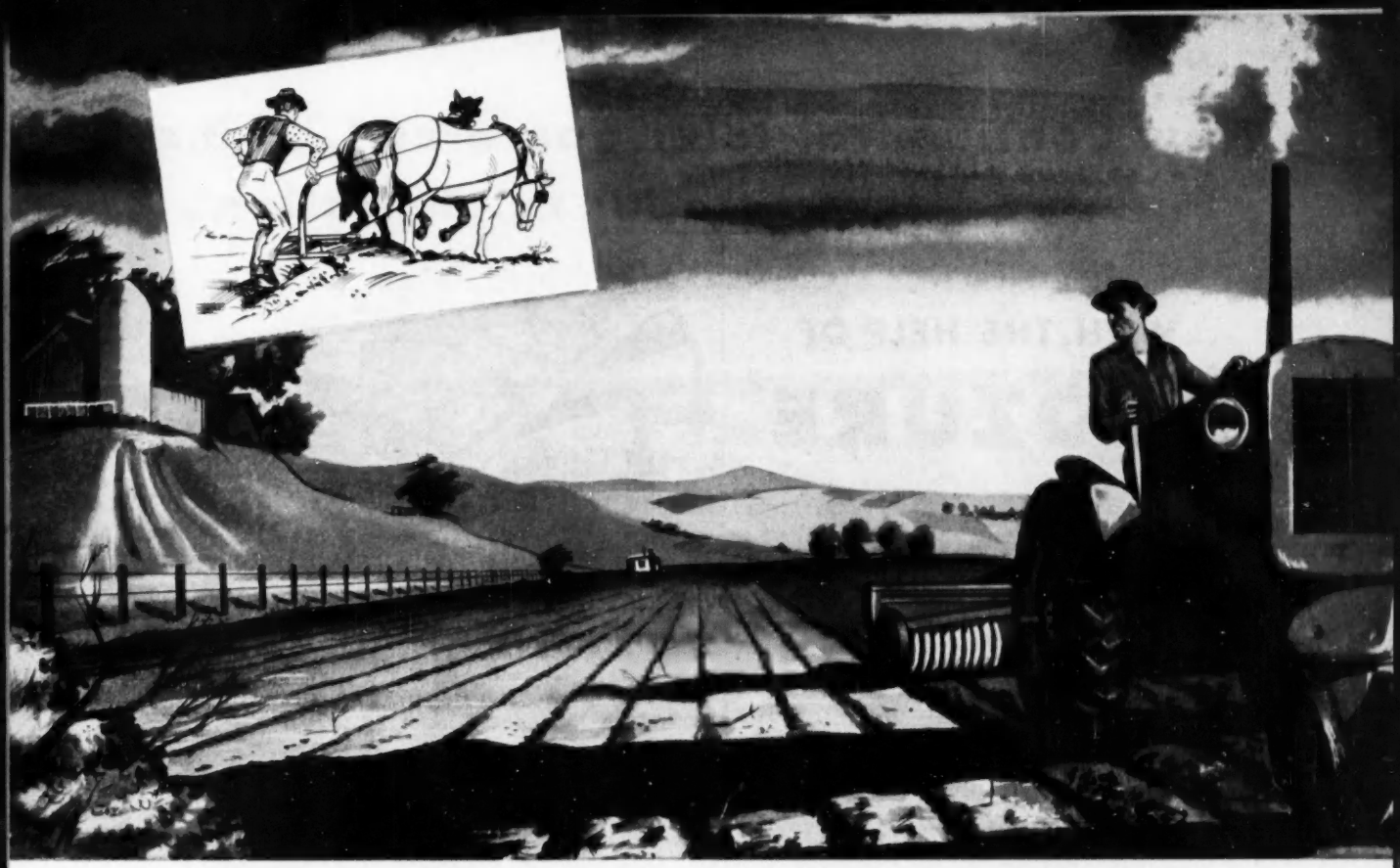
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Steadily, since the colonial landings, American farmers have been harnessing nature to their use, but not until the mechanization of the past 50 years have the really great strides been made in yield per man hour.

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Burgess-Norton is grateful for the opportunity to play a role in the production of this equipment, building for the industry piston pins, crawler type track bushings, commercial bearings, and a variety of stamped and machined brazed assemblies.



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GENEVA, ILLINOIS

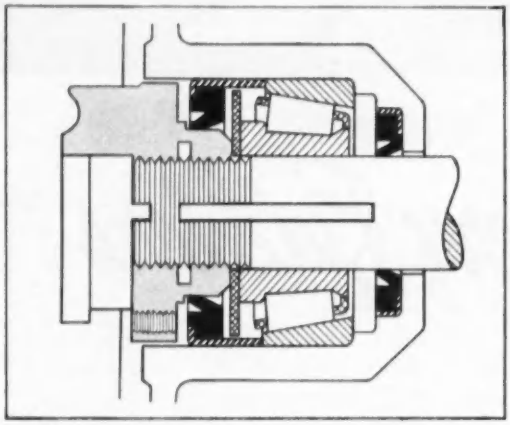
SERVING INDUSTRY FOR 50 YEARS



New Continental Idler operates 1, 2, 3, or more years without relubrication . . .

WITH THE HELP OF KLOZURE* Oil Seals





The new Continental UST idler uses two KLOZURE Oil Seals—one outboard and one inboard—to insure maximum bearing protection.

This UST factory-sealed belt conveyor idler, developed by The Continental Gin Company, was designed primarily to cut maintenance costs and insure a longer life for both the belt and idler assembly. Continental engineers wanted an idler that would operate satisfactorily without re-lubrication for one, two, three, or more years. That's why they chose a pre-lubricated sealed unit incorporating tapered roller bearings and dependable KLOZURE Oil Seals.

Garlock KLOZURES protect the bearings on Continental idlers by keeping the lubricant *in*, the dirt and moisture *out*. In addition, the KLOZURE assembly prolongs belt life by preventing the leakage of grease on to the belt.

For positive bearing protection specify KLOZURE Oil Seals for your machinery. KLOZURES are made in many models and in a complete range of sizes.

Write for Klozure Catalog No. 10.



Model 71-A Springless KLOZURE, the inboard seal



Model 71-A-7 Springless KLOZURE, the outboard seal

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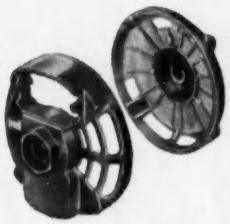
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Motor End Frames



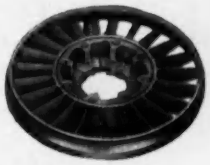
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Garbage Disposer Housing



Aircraft Piston



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Carbon Pile Regulator



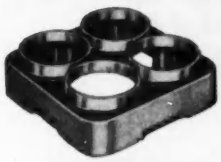
Steel-Belted Piston



Alternator Housing



Diesel Permanent Mold Piston

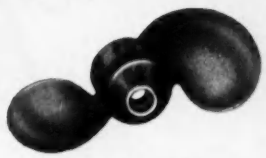




Rocket Carrier Base



Air Connector



Outboard Propeller

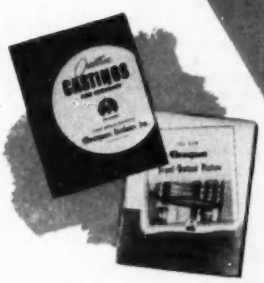


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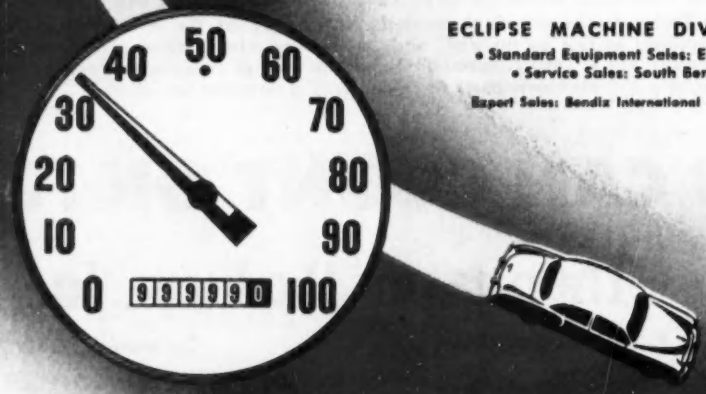
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Judge Value As Your Customers Will — on *Lasting Performance!*

The performance of the car you build and sell *today* may very well be the deciding factor in some *future* automobile sale. It is just good business, therefore, to choose your engine components on the basis of *long-range economy*. In carburetors, the name Stromberg is famous for better performance —it is also a fact that Stromberg Carburetors *last longer*. Judge value as your customers will and you will agree— Stromberg* Carburetors are the logical choice.

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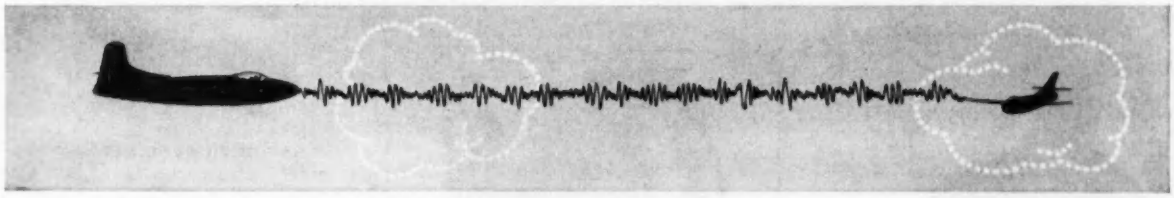
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to lock this twin-jet fighter on its prey . . .



—the Douglas F3D Skyknight

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Designed for the U. S. Navy, the all-weather Skyknight flies at near-sonic speeds, operates from aircraft carriers as well as small advanced airfields. A side-by-side seating arrangement of pilot and radar operator results in closer combat teamwork—permits Skyknight's modern radar *search* and *fire control* equipment to be operated with maximum efficiency when against marauding enemy planes.

Performance of F3D Skyknight in action is another example of Douglas leadership in aviation. Planes that can be produced in quantity *to fly faster and farther with a bigger payload* are a basic rule of Douglas design.



Be a Naval flier—write to
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Depend on *DOUGLAS*  **First in Aviation**

MILLIONS OF HOURS AHEAD
in lightweight turbo-machinery!



Today, AiResearch has a backlog of *25 million hours of actual operating field experience* in lightweight turbines. These units provide auxiliary power, starting power, pressurization, heating and refrigeration for U. S. aircraft. With rpm's ranging from 10,000 to 100,000, average efficiency is 83%.

The many thousand AiResearch turbine machines now in operation are the result of a pioneering development and manufacturing program begun 9 years ago. In its course more than 2 and ¼ *million* hours were spent in engineering development, plus over 100,000 hours of laboratory tests.

This *experience* where others are still exploring is typical of AiResearch leadership in the small but highly efficient power and control units required in the many fields of modern industry.

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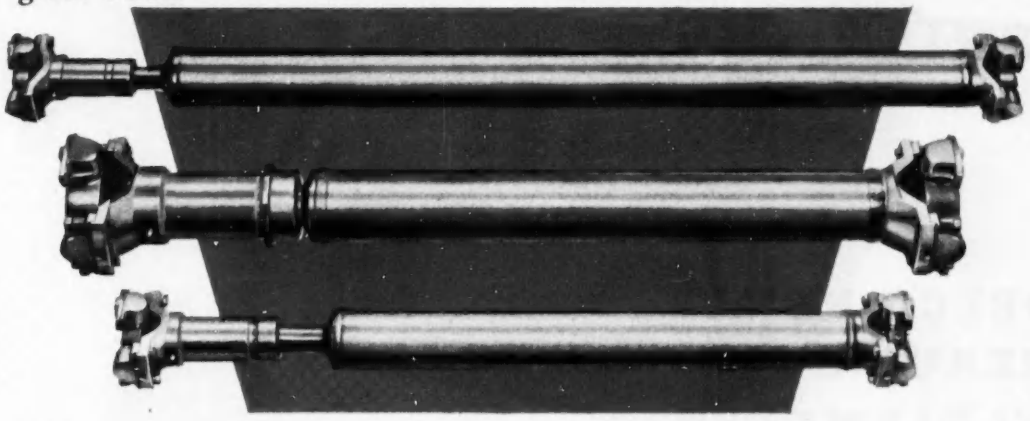
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If your truck must have large size universal joints — with a long propeller shaft—and operate at high speeds—it will pay you to specify MECHANICS "C" Type UNIVERSAL JOINTS with a 4″ or 4½″ diameter PROPELLER grade TUBE —



This combination provides strong, smooth running drive lines — with a substantial reduction in weight. Let MECHANICS engineers help develop a stronger, lighter, smoother running drive line for *your* truck, or other heavy duty equipment.

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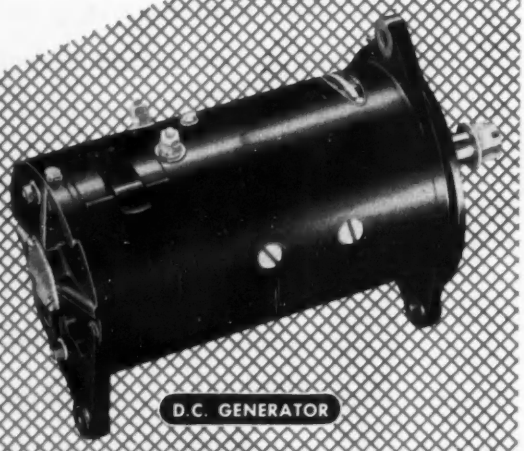
Roller Bearing BW

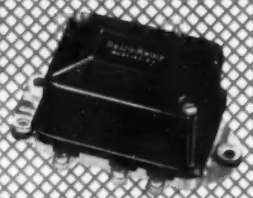
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Right for the Job!







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Delco-Remy heavy-duty 5⅝" diameter generators are favorites with users who need units that develop full output at relatively low engine speeds. These Delco-Remy generators have exceptionally long brush life (100,000 miles or more is common) and, because of their durable construction and simple, dependable lubrication system, require a minimum of maintenance.

Heavy-duty features include an extra-heavy, rigid armature shaft, extra-large brushes and commutator, ball bearings in both commutator and drive end frames, wick-type lubrication with oilers, and forced ventilation.

These generators, with a frame diameter of 5⅝ inches, are available in 6-, 12-, 24- and 32-volt models. Six-volt models have capacities as high as 55 amperes, 12-volt models as high as 50 amperes. The 24- and 32-volt models provide outputs of 20 and 15 amperes, respectively. Matching regulators are available for all models. Specify Delco-Remy heavy-duty generators with mounting brackets and pulleys when ordering new vehicles.

DELCO-REMY
Division, General Motors Corporation
Anderson, Indiana

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measuring speed and frequency

- **Takes Less Space (12" x 12" x 8")**
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STANDARD

Write for Bulletin #200

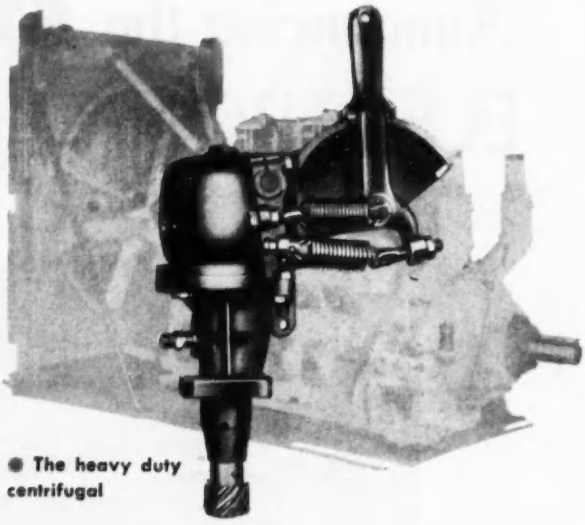
The STANDARD ELECTRIC TIME COMPANY

87 LOGAN STREET • SPRINGFIELD 2, MASSACHUSETTS

PRECISION TIMERS • CHRONO-TACHOMETERS • LABORATORY PANELS • PIPELINE NETWORK ANALYZERS



● The little 1400 series



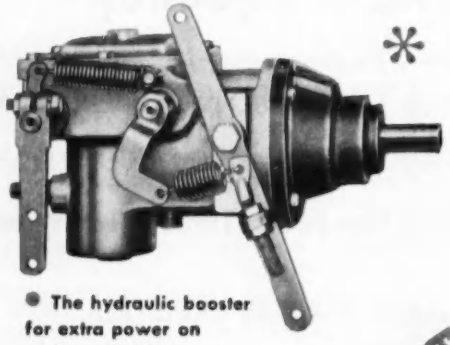
● The heavy duty centrifugal

PIERCE GOVERNORS

preferred for gas (LPG), gasoline and diesel industrial engines... big, medium and small



● The standard long range 900 series



● The hydraulic booster for extra power on racks and valves

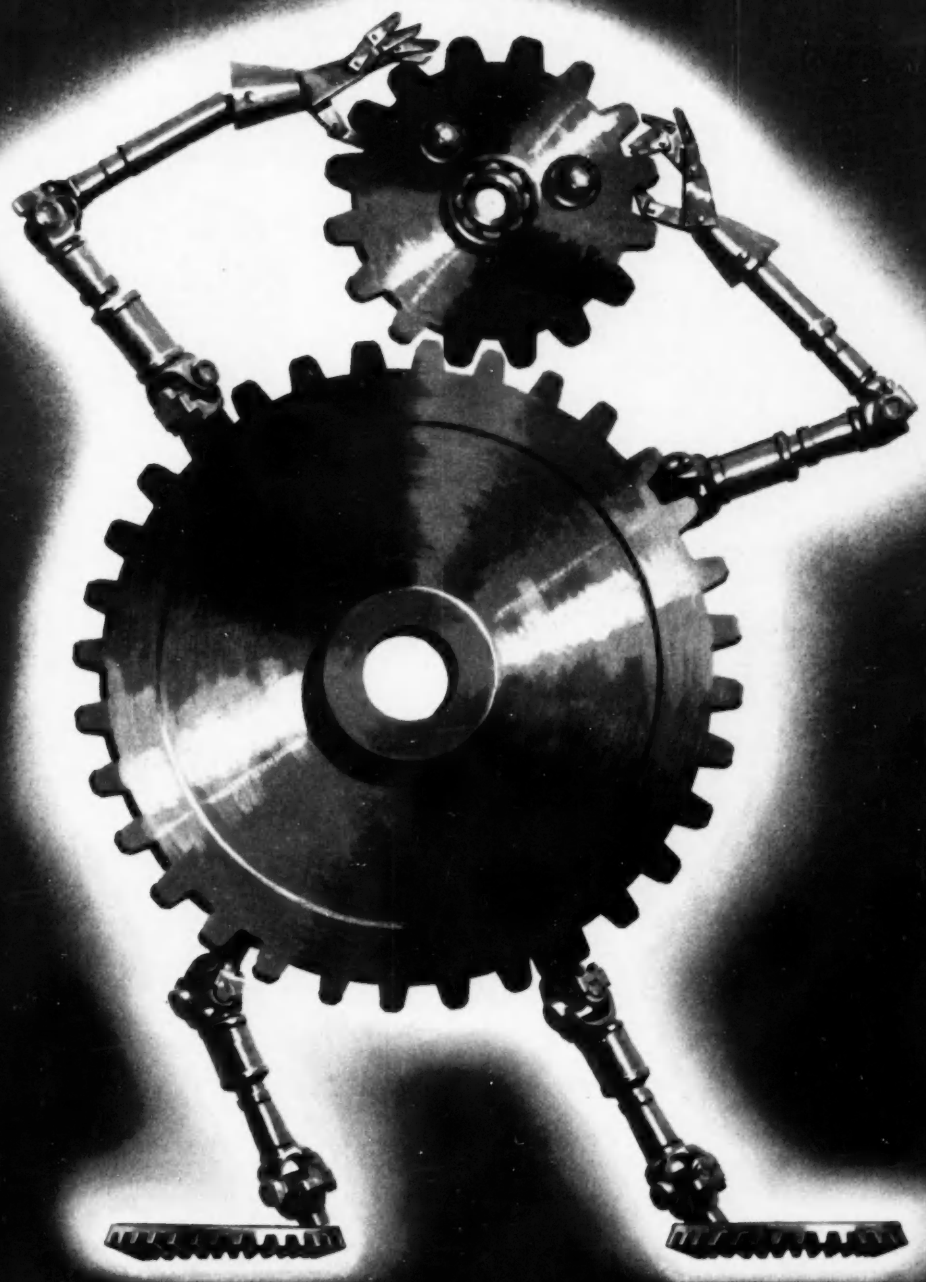
Pierce centrifugal governors are your most dependable and efficient control mechanisms for industrial engines . . . from small generator sets to monster power units . . . gas (LPG), gasoline or diesel. For engines requiring extra power to position fuel rack or valve, the Pierce centrifugal with hydraulic booster * (for original equipment only) is ideal! Pierce offers a ready solution to most engine governing problems . . . send full details and specifications on your particular problem. Complete engineering service available.

PIERCE — THE MARK OF QUALITY

THE PIERCE GOVERNOR CO., INC.

1602 OHIO AVENUE, ANDERSON, INDIANA

"World's Most Experienced Governor Manufacturer"

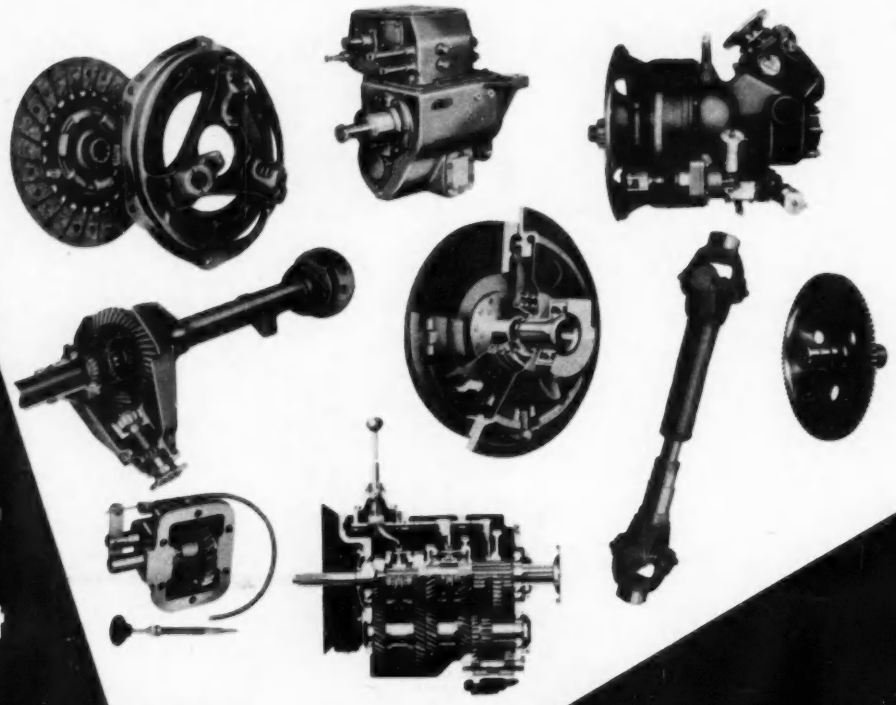


We specialize in making things come out right

Spicer has developed a fine balance between mechanical excellence and human efficiency during the past 50 years. This combination makes things come out right . . . in the plant . . . in the field. It is one of the big reasons why Spicer power transmission units have become the

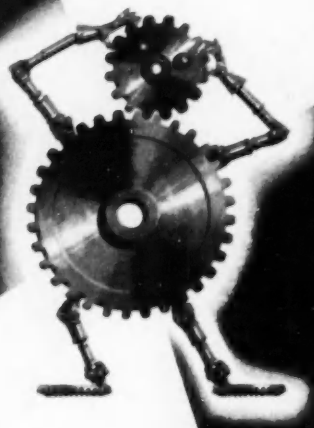
Standard of the Industry

Designing, Developing, Engineering, Manufacturing and Service



CORRECT
in the plant

With 10 modern plants doing much of their processing from raw material to finished product . . . with engineering genius and manufacturing skill of the highest order . . . Spicer controls and maintains quality standards acclaimed in the industry.



CORRECT
on the road

Millions and millions of automotive vehicles of every type have proved the correctness of Spicer equipment with billions of service miles throughout the world. Spicer "follow-through" in the plant pays big dividends to the automotive manufacturer and his buyers . . . in performance and prestige.

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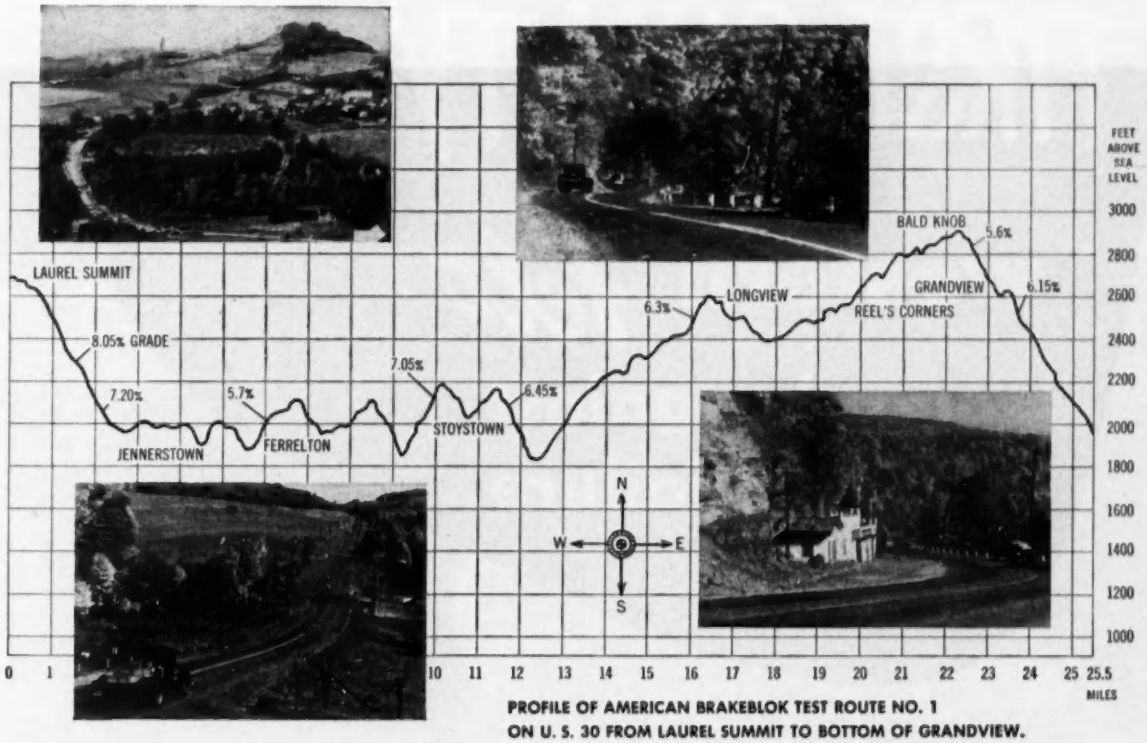


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TORTURE TRACK *25.5 MILES LONG!*



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ON U. S. 30 FROM LAUREL SUMMIT TO BOTTOM OF GRANDVIEW.

. . . to develop the best brake lining for you

American Brakeblok Test Trucks follow this course daily. Under all conditions of load the lining is put through every possible test—performance, fade, recovery, moisture sensitivity, wear, glaze, and maximum heat resistance. Accurate instrumentation records test data for interpretation by our research staff.

The mountains of Pennsylvania were selected because of their sharp grades, long descents, hairpin curves and dangerous intersections, giving the best opportunity for testing brake lining through a wide range of operating conditions.

On this track . . . today's brake linings are perfected—tomorrow's proven . . . for maximum safety, performance and life.

American Brakeblok

THE SAFETY BRAKE LINING

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western Felt guards against product failure...



Felt is not "just felt." There is a vast difference in its uniformity, treatment, manufacture and efficiency. Western Felt, for over fifty-three years has not and will not, depart from its policy of maintaining the highest possible quality in material and manufacture. Its products, wherever they may be employed, are your insurance against product complaints due to a Western Felt component part. Here are just a few of its features that you can always depend on: range from wool softness to rock hardness—never loses shape—does not ravel or fray—resists oil, water, heat, age, resilient, flexible, compressible—may be cut to extremely close tolerances for small parts—unsurpassed in uniformity.

Western Felt engineers with decades of experience in the use of felt stand ready to counsel you.

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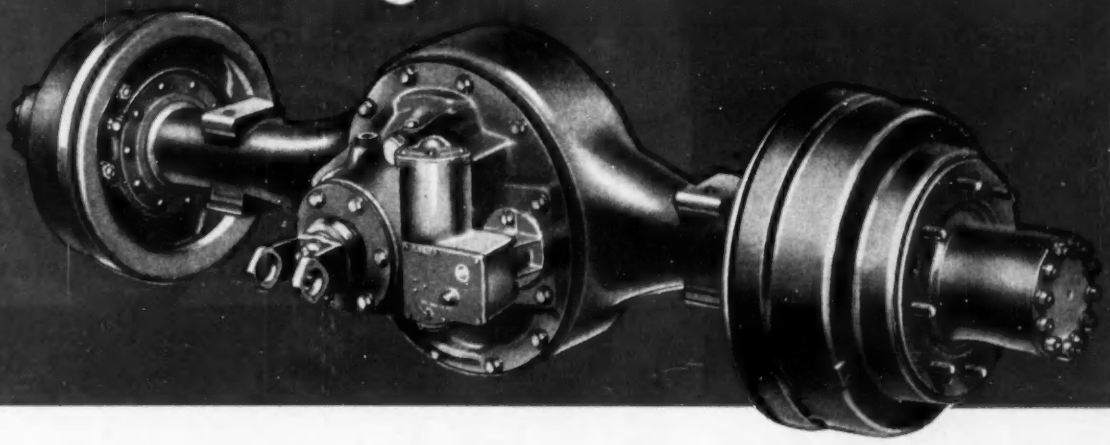
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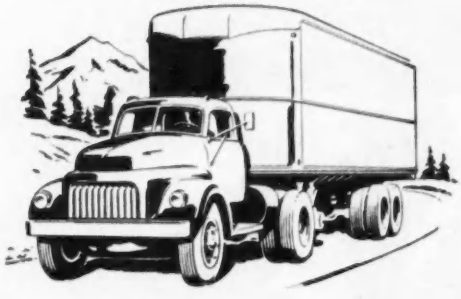
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Sheet and roll felt manufactured for special purposes and to meet all S.A.E. and military specifications.

With Eaton 2-Speed Axles, a cost-cutting gear ratio for every road and load





More than a million-and-a-half Eaton 2-Speeds in trucks today!

Eaton 2-Speeds enable drivers to select the right gear ratio for every operating condition—starting out under full load, climbing grades, high-balling, quick shifting in traffic. Engines operate in their most efficient speed range, reducing stress and wear on vital truck parts. Operating and upkeep costs are at a minimum; trucks last longer, are worth more when traded in. Eaton 2-Speed Axles give trucks power when needed, speed when wanted.

EATON

AXLE DIVISION

MANUFACTURING COMPANY

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PRODUCTS: Sodium Cooled, Poppet, and Free Valves • Tappets • Hydraulic Valve Lifters • Valve Seat Inserts • Jet Engine Parts • Rotor Pumps • Motor Truck Axles • Permanent Mold Gray Iron Castings • Heater Defroster Units • Snap Rings Springtites • Spring Washers • Cold Drawn Steel • Stampings • Leaf and Coil Springs • Dynamatic Drives, Brakes, Dynamometers



DOWN DEEP in the engines of millions of American automotive vehicles are virtually "buried" many millions of dependable, treasured Johnson Bearings. Seldom gaining recognition beyond the car manufacturer, they are content to contribute faithfully their important share to good car performance. They must be manufactured with care and precision to do the job . . . and each Johnson Bearing is. Every driver of one of those vehicles puts his faith in them.

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JOHNSON B BEARINGS
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What Do You Want Most in Tube Fittings?

NO LEAKS

ability to withstand VIBRATION

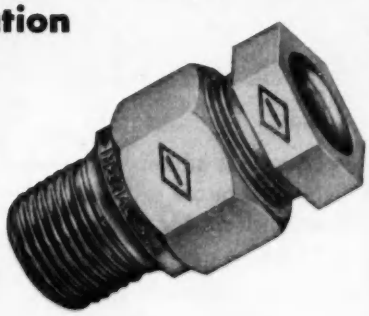
FASTER assembly

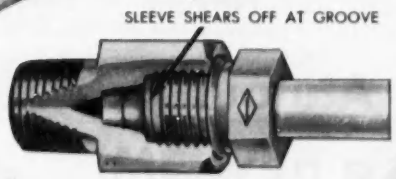
Get Them ALL in IMPERIAL Hi-Duty® FITTINGS



The Tube Coupling that will not leak even under vibration

Imperial Hi-Duty Fittings withstand over 5 times as much vibration as ordinary Compression or Flared brass fittings. Design of sleeve minimizes deformation of tubing in assembly—tubing is kept stronger at points of greatest stress. Trouble-proof performance proved by widespread use in severe applications.





- ★ For Tubing ⅛" to ¾" O.D.
- ★ Available in Brass or Aluminum
- ★ Ask for Bulletin No. 3002

Easier and Quicker to Assemble

Fitting comes with nut assembled. To get a tight joint, simply insert tube into fitting and tighten nut. No loose sleeve to drop . . . no flaring required. Makes repeated tight reconnections.



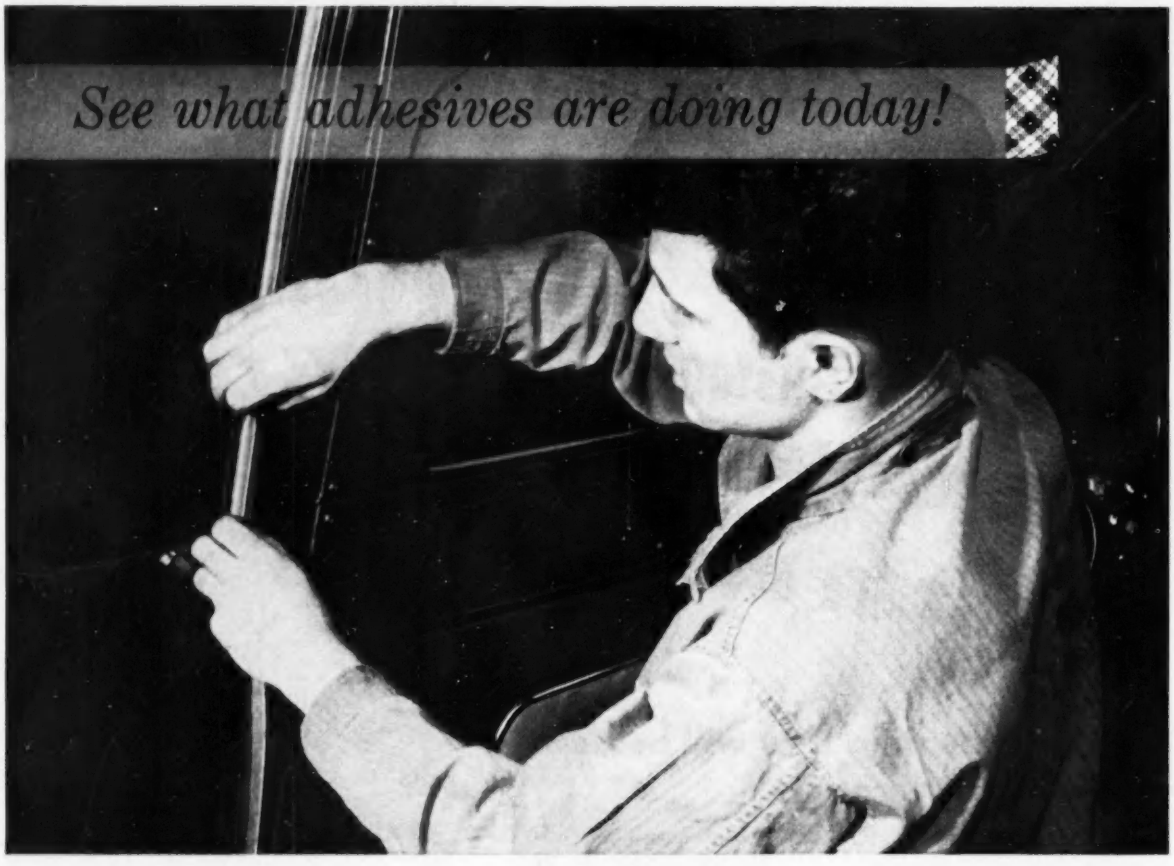
With IMPERIAL you can be sure of the finest in fittings . . . fittings that have *forged* bodies on elbows and tees providing greater strength and toughness . . . *long* Dryseal pipe threads for extra assurance of tight pipe connections. See Catalog 3500.

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Pioneers in Tube Fittings and Tube Working Tools



Announcing a new 3M weatherstrip adhesive

Here's a new 3M adhesive, developed especially to withstand the high-temperature extremes encountered in extensive periods of hot-weather driving.

It's EC-1300—a new, fast-grabbing weatherstrip adhesive that has been rigorously tested *and proved* in the field by leading automotive companies. Results of these tests show that EC-1300 successfully resists interior car temperatures up to 158° F. (This temperature was recorded in one of the cars tested on a desert run.)

What's more, EC-1300 takes hold quicker than any previous 3M weatherstrip adhesive. This means not only faster production but better production, too.

See what adhesives can do for you . . .

If weatherstripping is one of your operations, you'll appreciate EC-1300. It is by far the best weatherstrip adhesive ever made by 3M, supplier of tailored adhesive products for the automotive industry. For more detailed information, contact your 3M salesman, or write to 3M, Dept. 99, 417 Piquette Ave., Detroit 2, Mich.

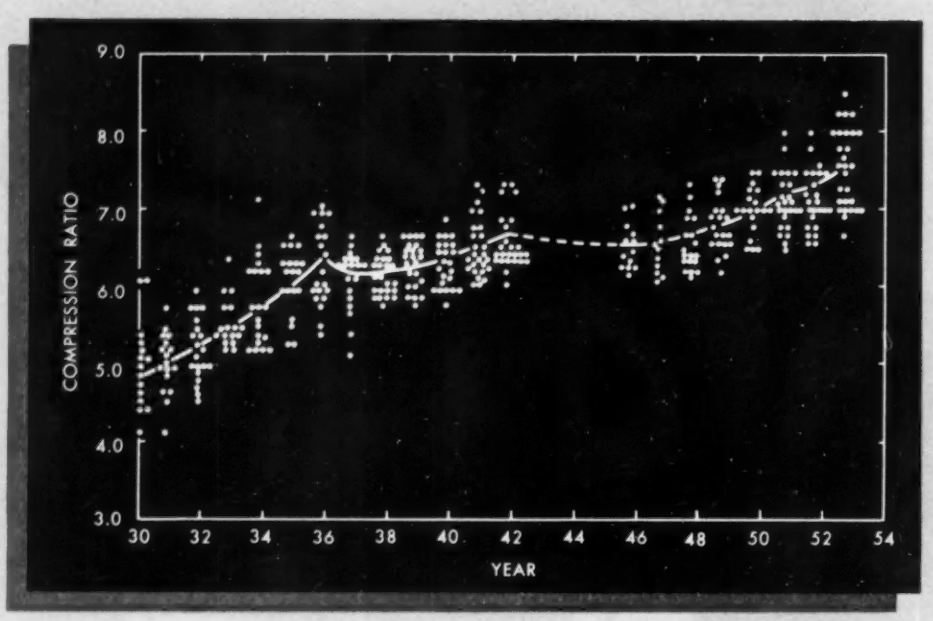
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YOU'LL NEVER FIND
a squirrel caught short
The smell of burning leaves, the first chill breeze . . . they're quick to set our bushy-tailed friend about his autumn ritual. Scampering here, then there— he's making ready . . . filling the larder in his tall-timbered penthouse.
New product development need never catch you unprepared if you play it shrewd and plan ahead. Planning helps put things in place – gives you the opportunity to look into the advantages of castings. Campbell, Wyant and Cannon, for many years a leader in metallurgical engineering, precision control and mechanized production – provides you with castings that machine easier, wear longer and facilitate greater design flexibility. Castings by CWC do all this and more . . . at much less cost.
Why not let CWC help you tree a better product? Maybe then you'll have the time to hunt up some new trophies – please no squirrel tails.
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Manufacturers of Gray Iron, Alloy Iron, and Steel Castings
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Since 1908

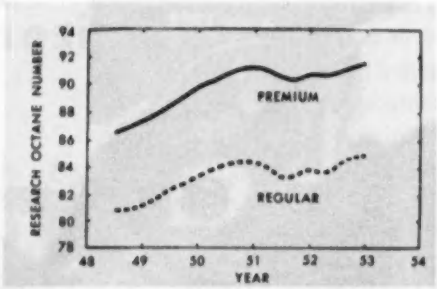


Increase in compression ratios of American passenger cars since 1930.

How does *Pre-Ignition* affect Future Improvements in Gasoline Engines?

The DU PONT PETROLEUM LABORATORY reports some significant findings on this important subject . . .

Pre-ignition, which is little understood at the present time, threatens to limit further improvement in the efficiency of fuel utilization in passenger car engines.



Recent trends in average research method octane numbers of regular and premium grade gasolines permitting increased engine efficiency.

The problem assumes increasing importance as the compression ratios of gasoline engines are pushed steadily upward (as indicated in the chart above), and the need for a solution becomes more pressing. There is, therefore, a growing demand for the cooperative development of suitable test methods which will enable the automotive and petroleum industries to study pre-ignition. Du Pont is helping in this.

WHAT IS PRE-IGNITION?

Pre-ignition may be defined as *ignition of a gasoline-air mixture in a combustion chamber by a hot surface before the spark plug fires.*

Pre-ignition manifests itself in several ways. Here are three of the most important:

1. Wild ping—These loud, sharp and erratic cracks generally take place in one or two cylinders at low speeds either at part throttle or at full load.

2. Thudding—This low-frequency vibration of the engine structure is caused by an extremely early ignition of the charge.

DUPONT SUPPLIES A COMPLETE LINE OF GASOLINE ADDITIVES

Tetraethyl Lead Compounds (Motor Mix—Aviation Mix) • Antioxidants • Metal Deactivator • Dyes

Also: Fuel Oil Stabilizer • Grease Stabilizers

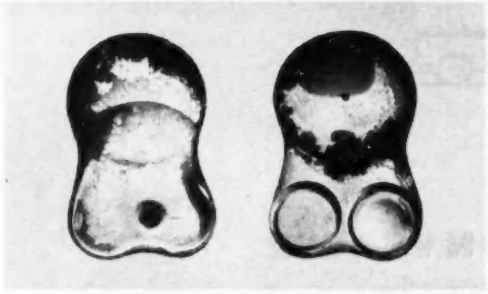
3. Run-on or after-running—Continued engine operation after the ignition is turned off generally occurring when the switch is cut during idling or road operation under load.

Two of the important factors involved in pre-ignition are the tendencies of combustion-chamber deposits to glow and cause surface ignition of the charge; and the ability of fuels to withstand ignition by hot surfaces.

DEPOSIT GLOWING

The glowing tendencies of deposits are dependent upon the rapid oxidation of carbonaceous materials at very high temperatures and under the catalytic influence of metal salts.

Glowing deposit particles exert pre-ignition harm either when attached to the combustion-chamber wall or while they are floating about as flaked particles in the working fluid for one or more cycles before they are blown out past the exhaust valve.

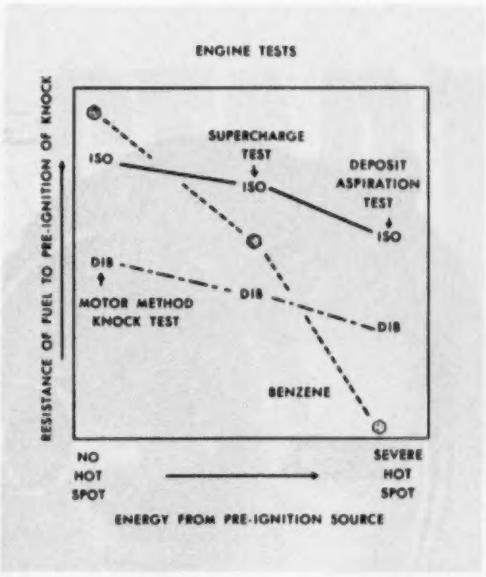


Flaked appearance of combustion-chamber deposit formed in a car operated for 5,200 miles under low-duty conditions.

Because glow must be present to cause pre-ignition, combustion-chamber deposits which are curled away from the walls and which can break off easily are more harmful than those that are tightly adherent. Such deposits are formed most readily under mild-duty operating conditions such as city driving.

ABILITY OF FUELS TO WITHSTAND IGNITION BY HOT SURFACES

At the Du Pont Petroleum Laboratory several test procedures have been used for evaluating the pre-ignition resistance of fuels in engines. When the composition of the fuels was varied over a wide range, from isooctane thru diisobutylene to benzene, pronounced differences in fuel behavior were exhibited. The relative rating of these fuels varied



Effect of Hot-Spot Severity on Relative Ratings of Benzene, Diisobutylene, and Isooctane in Engine Tests.

with the test conditions, particularly in relation to variation in hot spot severity.

For example, with a very hot igniter, isooctane is best, diisobutylene is intermediate and benzene is poorest. However, with an ignition surface of intermediate severity, diisobutylene is worst and isooctane is best. With no hot spot at all, still a third order of rating was shown to exist. These findings are illustrated in the chart above.

While it has been found that pre-ignition tendencies of individual hydrocarbons vary quite widely in laboratory tests, the practical significance of this property has not yet been determined in extended road tests.

This work on pre-ignition is part of a continuing research program at the Du Pont Petroleum Laboratory. Since Du Pont is a major supplier of tetraethyl lead and other gasoline additives, the aim of this program is to help refiners improve fuel performance through the use of additives.

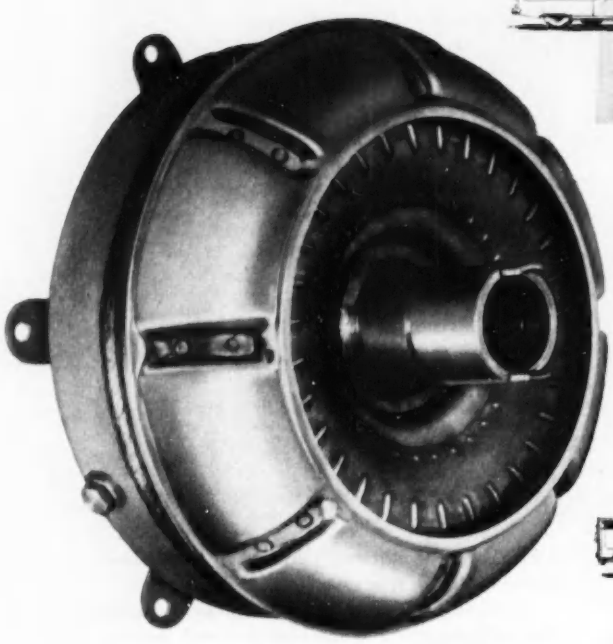
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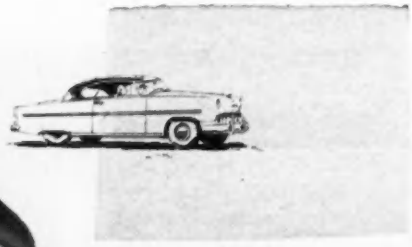
Petroleum Chemicals

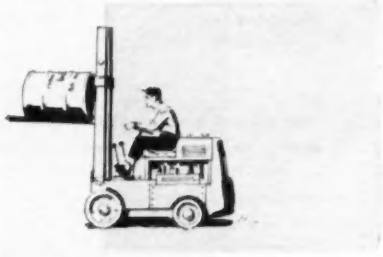
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The Long Torque Converter provides smoother, faster, more economical operation for industrial trucks. Combined with a hydraulically-operated clutch it provides even greater flexibility in use.

Available in 11- and 12-inch diameters, for engines ranging from 90- to 200-lbs-feet torque, the Long design is easily modified for a wide variety of other applications. Its design, incorporating use of economical stampings and leakproof welding, assures *low* cost.

To prospective users of converters in these capacities, we offer low cost production and our complete engineering cooperation.

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be sure at the START

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CUSTOM-BUILT battery



Globe-Union batteries are creatively engineered for original equipment manufacturers. (As well as numerous private brands.) They are also produced for mass merchandising under the name GLOBE "Spinning Power".

For low freight costs and fast service, there's a Globe-Union factory located near your major markets (see below). And, to provide better service to the great Southwest, we've added a new plant at Houston, Tex.

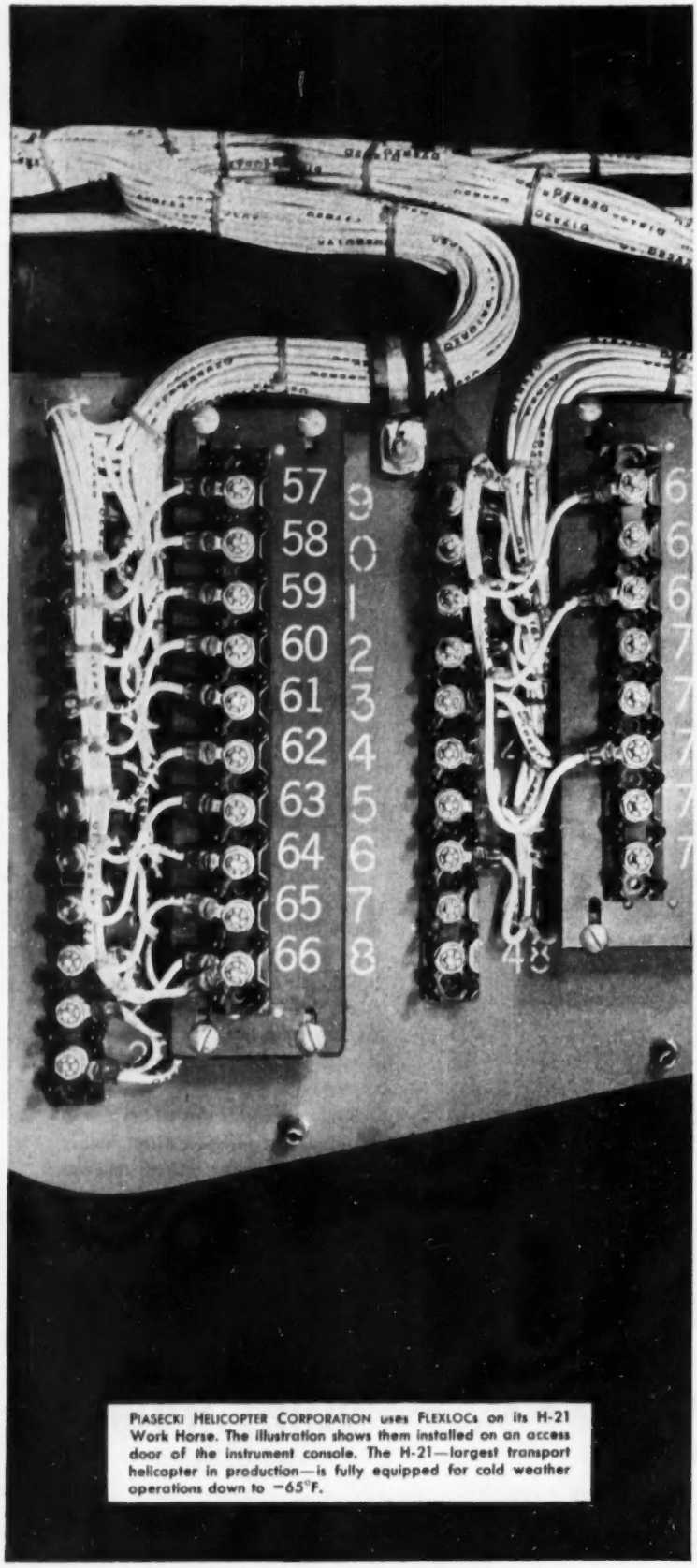
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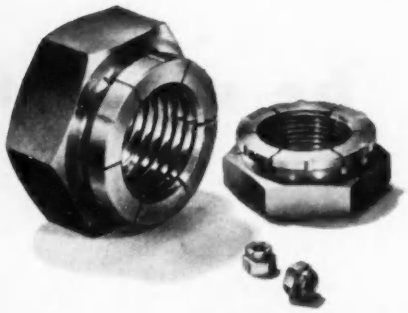
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PIASECKI HELICOPTER CORPORATION uses FLEXLOCs on its H-21 Work Horse. The illustration shows them installed on an access door of the instrument console. The H-21—largest transport helicopter in production—is fully equipped for cold weather operations down to −65°F.



Why use FLEXLOC locknuts?

The answer is simple. They hold assemblies together, and won't work loose like ordinary nuts. Once you install these one piece, all metal nuts, you can forget them. Yet they can be easily removed and can be reused again and again.

No fastening job is too tough for a FLEXLOC. Whether it's on an access door of a Piasecki Helicopter or the picker stick of a high speed loom, a FLEXLOC stays put.

FLEXLOCs save production and maintenance time. They are one piece, all metal—nothing to assemble, come apart, lose or forget. Standard FLEXLOCs have higher tensile than most other nuts—and because they are all metal, are not affected by temperatures to 550°F.

SPS can deliver any quantity of FLEXLOCs in a wide range of sizes. Stocks are carried by industrial distributors. Write for literature and samples. SPS, Jenkintown 55, Pa.

FLEXLOC®

LOCKNUT DIVISION

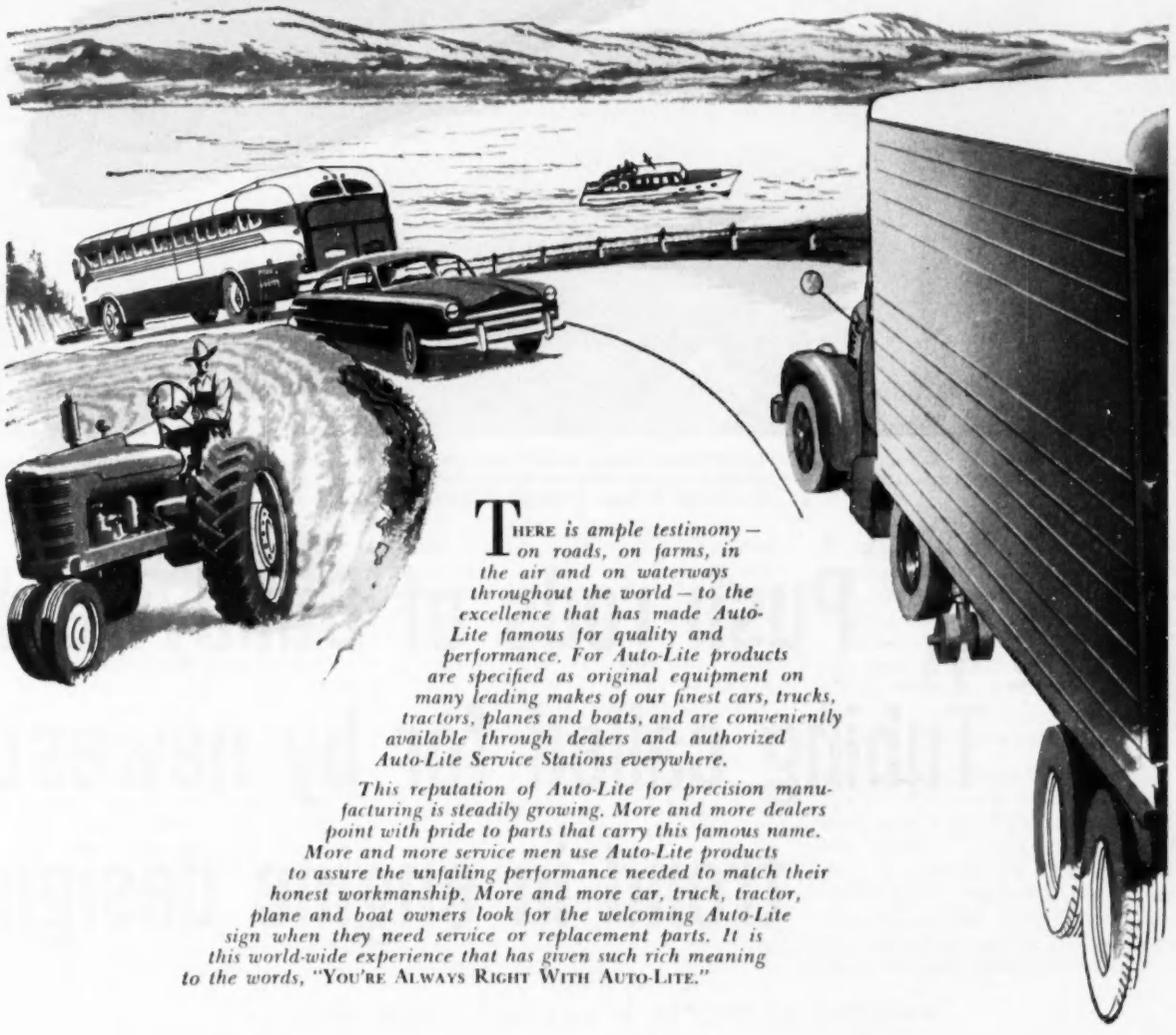
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JENKINTOWN PENNSYLVANIA

Our Fiftieth Year : A START FOR THE FUTURE



Serving the world's constant demand for better transportation!



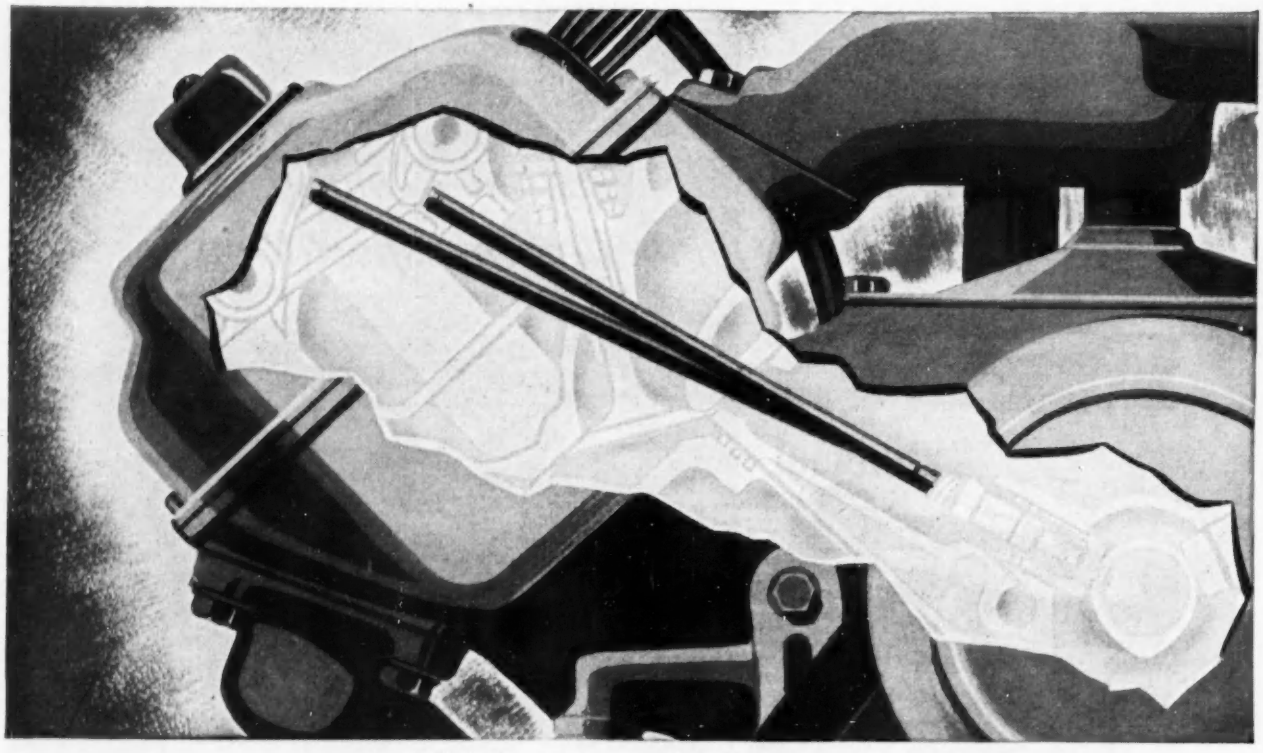
THERE *is ample testimony — on roads, on farms, in the air and on waterways throughout the world — to the excellence that has made Auto-Lite famous for quality and performance. For Auto-Lite products are specified as original equipment on many leading makes of our finest cars, trucks, tractors, planes and boats, and are conveniently available through dealers and authorized Auto-Lite Service Stations everywhere.*

This reputation of Auto-Lite for precision manufacturing is steadily growing. More and more dealers point with pride to parts that carry this famous name. More and more service men use Auto-Lite products to assure the unfailing performance needed to match their honest workmanship. More and more car, truck, tractor, plane and boat owners look for the welcoming Auto-Lite sign when they need service or replacement parts. It is this world-wide experience that has given such rich meaning to the words, "YOU'RE ALWAYS RIGHT WITH AUTO-LITE."

AUTO-LITE *Manufacturers of...*

BATTERIES • BUMPERS • FUEL PUMPS • HORNS • GENERATORS
LIGHTING UNITS • SPEEDOMETERS • SPEEDOMETER CABLE
SWITCHES • STARTING MOTORS • INSTRUMENTS & GAUGES
IGNITION UNITS • MOULDED PLASTICS • WINDSHIELD WIPERS
WINDOW LIFTS • SEAT MOVING MECHANISMS • HUB CAPS
WIRE & CABLE • SPARK PLUGS • METAL FABRICATED
ASSEMBLIES • GRAY IRON CASTINGS • ZINC &
ALUMINUM BASE DIE CASTINGS

WORLD'S LARGEST INDEPENDENT MANUFACTURER OF AUTOMOTIVE ELECTRICAL EQUIPMENT



1 Today's sharp swing toward higher horsepower overhead engines for passenger cars has resulted in many new solutions to old automotive problems. One result: Push rods of Bundyweld Tubing, long proved in truck engines.



Push rods of Bundyweld Tubing called for by newest trend in engine design

WHY BUNDYWELD IS BETTER TUBING



Bundyweld starts as a single strip of copper-coated steel. Then it's . . .



continuously rolled twice around laterally into a tube of uniform thickness, and



passed through a furnace. Copper coating fuses with steel. Result . . .

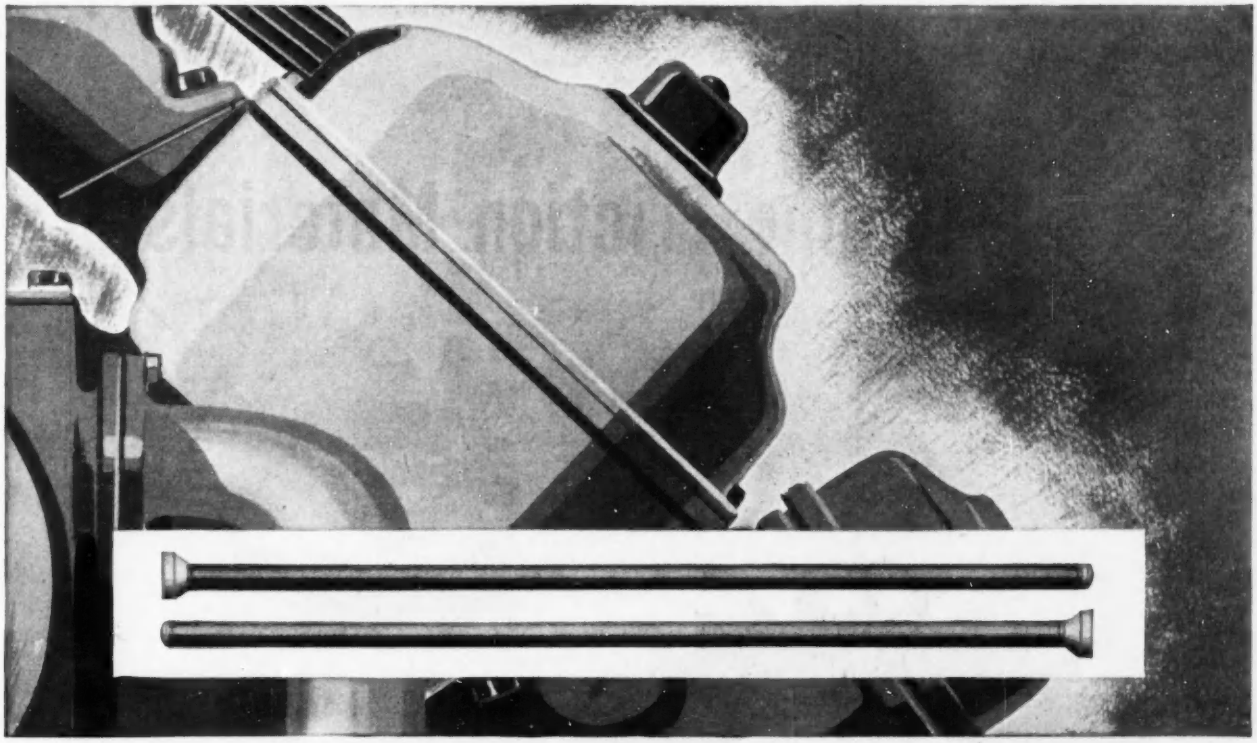


Bundyweld, double-walled and brazed through 360° of wall contact.



← **NOTE** the exclusive patented Bundyweld beveled edges, which afford a smoother joint, absence of bead and less chance for any leakage.

Bundy Tubing Distributors and Representatives: *Cambridge 42, Mass.:* Austin-Hastings Co., Inc., 226 Binney St. • *Chattanooga 2, Tenn.:* Peirson-Deakins Co., 823-824 Chattanooga Bank Bldg. • *Chicago 32, Ill.:* Lapham-Hickey Co., 3333 47th Place • *Elizabeth, New Jersey:* A. B. Murray Co., Inc., Post Office Box 476 • *Philadelphia 3, Penn.:* Rutan & Co., 1717 Sansom St. • *San Francisco 10, Calif.:* Pacific Metals Co., Ltd., 3100 19th St. • *Seattle 4, Wash.:* Eagle Metals Co., 4755 First Ave., South *Toronto 5, Ontario, Canada:* Alloy Metal Sales, Ltd., 181 Fleet St., East • Bundyweld nickel and Monel tubing is sold by distributors of nickel and nickel alloys in principal cities.



2 Tough, lightweight push rods of hardened Bundyweld reduce cam load, increase efficient function of entire valve train. Bundyweld fabricates more easily than the material it replaces, results in more uniform, better finished parts.

Push rods of Bundyweld, long used in powerful truck engines, help improve performance of powerful overhead-type passenger-car engines.

The improved push rods in the overhead engines of some of today's most popular cars are made of lightweight Bundyweld Tubing.

Lightweight push rods of Bundyweld reduce load on cam, and, of course, the entire valve train follows the cam more closely. The design engineer is thus able to produce a more efficient, more powerful overhead engine in keeping with today's constantly growing trend.

The tubing: Bundyweld is the only tubing double-walled from a single metal strip, with patented beveled edges. It's SAE 1010 steel, copper-bonded throughout 360° of wall contact into a strong, lightweight beadless tubing. Wall thickness and concentricity are uniform, accurate. Ultimate tensile strength, yield strength, and fatigue limit are exceptionally high.

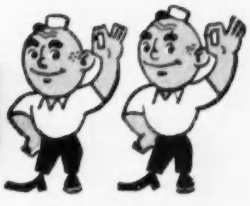
Engineering help: If you'd like help in determining how to apply Bundyweld toward solving your push rod problems, why not talk things over with one of our experienced automotive tubing engineers? You'll find them a prime source of sound information and ideas—not only on push rods but on other tubing applications.

Production: We're already mass-producing Bundyweld for automotive push rods. And, naturally, we're ready to give you the same high-volume, low-cost service we're giving others. We'll ship Bundyweld—cold drawn to proper hardness, held to specified low camber tolerances—right on schedule.

Let us show you what we've done—and what we can do for you—with push rods of Bundyweld Tubing. Perhaps you'd like to check into Bundyweld for your gasoline, oil, hydraulic window or brake lines, too. For details, write Bundy Tubing Company—world's largest producer of small-diameter tubing.

BUNDY TUBING COMPANY • DETROIT 14, MICHIGAN

Bundyweld® Tubing



DOUBLE-WALLED FROM A SINGLE STRIP

Moraine Friction Materials

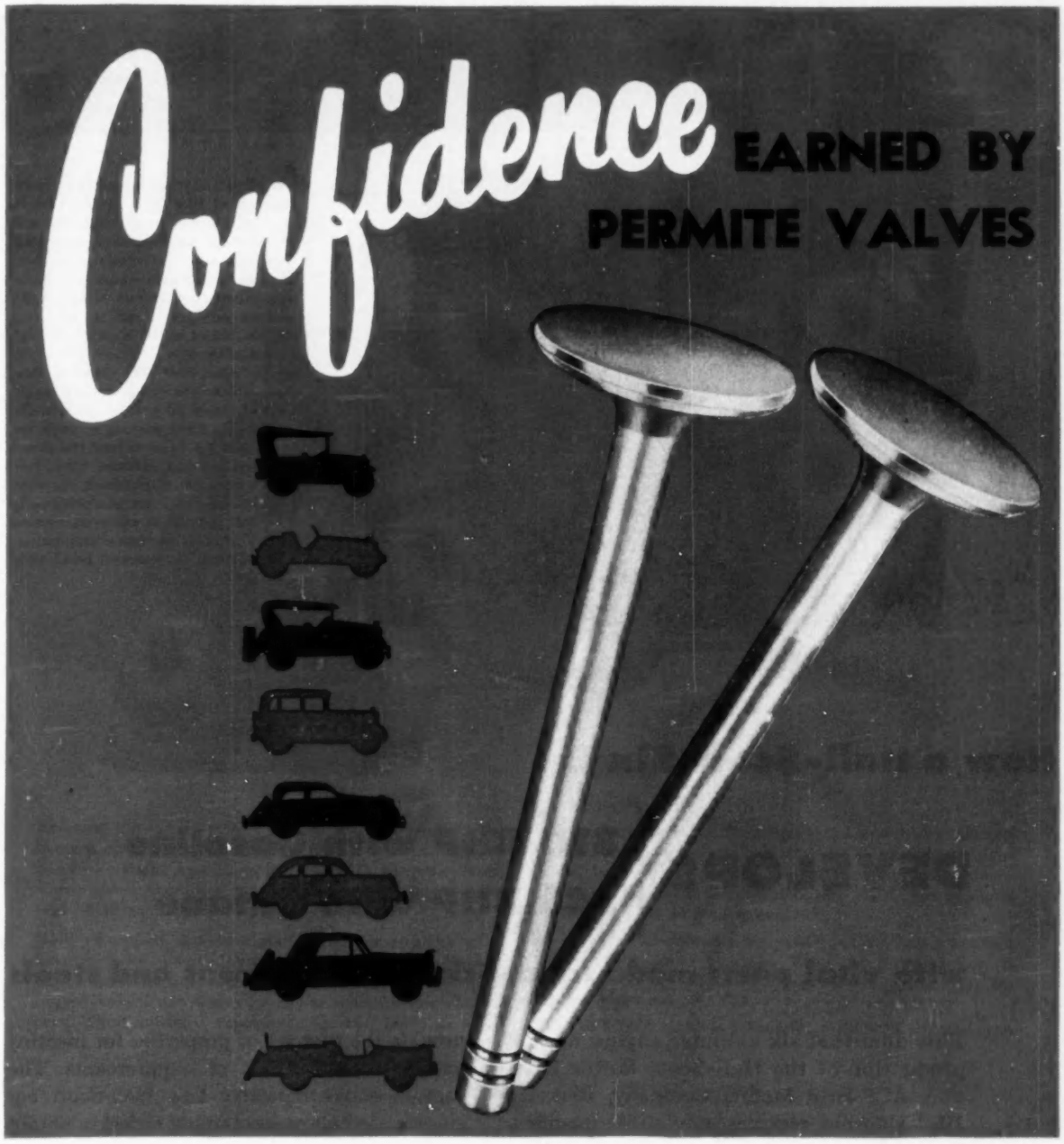


Moraine friction materials have a number of characteristics that make them highly useful to many industries. For example, by dispersing non-metallic materials uniformly through a semi-metallic or metallic matrix, the ultimate materials develop great resistance to wear and remain stable over a wide range of temperatures. In many cases the materials are bonded to a steel support which provides additional strength and increases the range of their application.

Moraine friction materials have proved themselves in automatic transmissions such as Powerglide, Dynaflow and Hydra-Matic. They are equally successful in special military vehicles and equipment, household appliances, and automatic transmissions for trucks of all sizes.

moraine products

DIVISION OF GENERAL MOTORS CORPORATION, DAYTON, OHIO



PERMITE

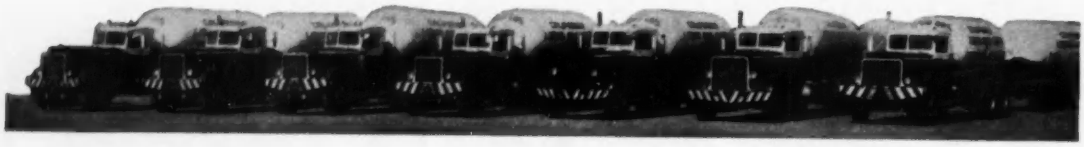
The confidence which automotive engineers have in Permite Valves has been earned through many years of dependable service to the automotive industry. Valves, pistons and other parts by Permite have contributed to the amazing advance in engine performance, as one improved model after another has been introduced during the past one-third century. We invite your requests for consultation and estimates on parts requirements.

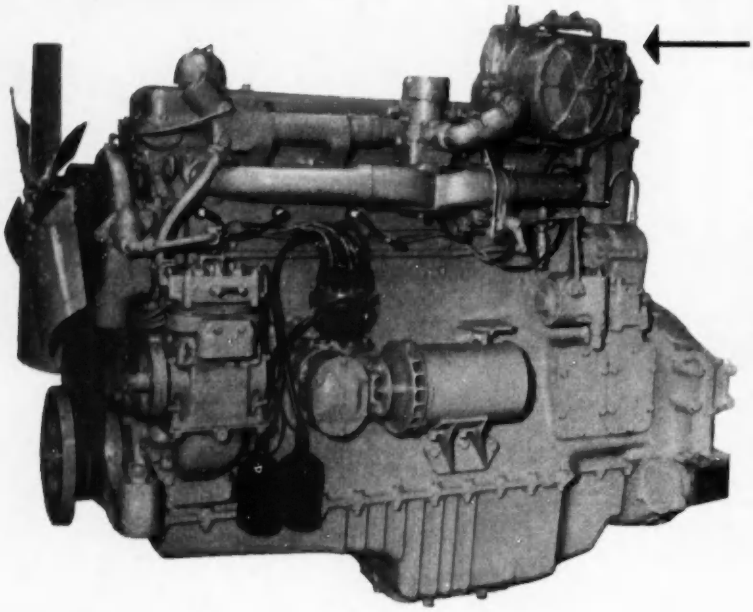
ALUMINUM INDUSTRIES, Inc. . . . Cincinnati 25, Ohio

Detroit: 809 New Center Building New York: 9 Rockefeller Plaza

Chicago: 64 E. Jackson Boulevard

ALUMINUM PERMANENT MOLD AND SAND CASTINGS . . . HARDENED, GROUND AND FORGED STEEL PARTS





Hall-Scott engineers specify cylinder heads and blocks in nickel alloyed iron to increase wear-resistance, and to improve machinability regardless of section size. To solve the problem of blow-by and assure maximum mileage between overhauls, they specify pistons equipped with a top ring groove insert of Ni-Resist®, a high nickel alloy iron... which effectively resists wear, heat and corrosion. And they utilize the strength and toughness of nickel alloy steel studs in the upper crankcase passing through the block and the head to hold the entire engine rigid and cylinder bores free from distortion. Crankshaft, connecting rods, valves... in fact, practically all vital parts are of alloys containing nickel to meet various combinations of operating, service and fabrication demands.

How a Hall-Scott Six

DEVELOPS { 310 BHP with Gasoline / 346 BHP with Butane

with vital parts made from nickel alloyed irons and steels

This dual-fuel six cylinder engine now in production at the Hall-Scott Motor Division, ACF-Brill Motors Company, Berkeley 10, California, requires only slight modifications to convert it from one fuel to the other.

Designed for trucks and industrial uses, this high-powered unit weighs but 2300 pounds and exemplifies how alloys containing nickel give greater play to the skill of automotive engineers.

From among the many engineering alloys containing nickel, you can select a material to provide the best set of properties for meeting one or a combination of requirements. The caption above indicates how Hall-Scott engineers used alloys containing nickel to obtain distinct advantages.

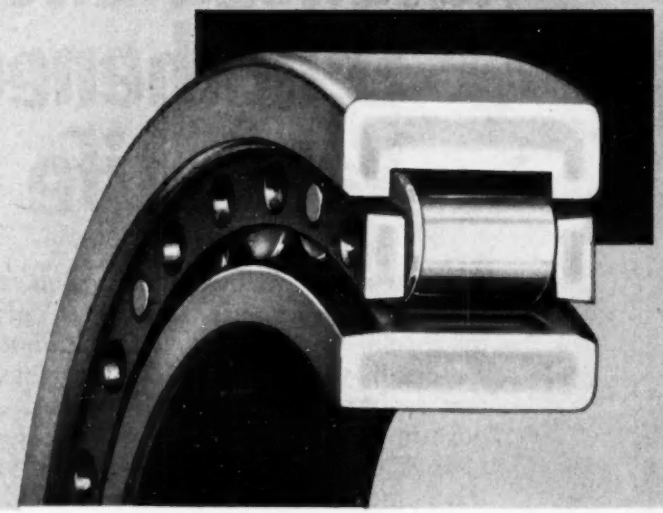
When you have a metal problem, send us details for our suggestions.

At the present time, nickel is available for end uses in defense and defense supporting industries. The remainder of the supply is available for some civilian applications and governmental stockpiling.

EMBLEM OF INCO SERVICE

THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK 5, N.Y.

Bower straight roller bearings carry maximum loads!



TWO-LIP RACE INCREASES RIGIDITY— IMPROVES ROLL ALIGNMENT

Examine the cutaway view of the Bower straight roller bearing, shown above. It is important to note particularly the two parallel lips made integral with the outer race. These lips or shoulders provide a rigid, durable construction—keeping the rolls in proper alignment.

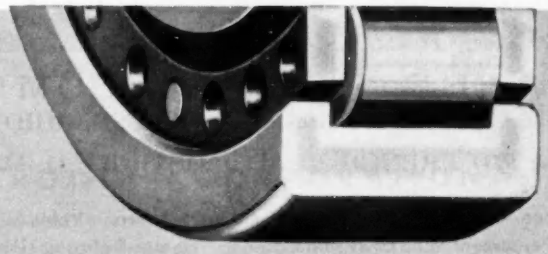
Built of highest quality materials, Bower straight roller bearings have proved themselves capable of standing up day in and day out under maximum loads and the most rugged conditions—with virtually no maintenance whatsoever. They are used extensively in such fields as automotive, earthmoving, farm equipment and heavy machine tool. For the aircraft industry, Bower builds straight roller bearings—especially designed for high-speed, high-temperature operation—which are used by virtually every producer of jet engines.

Whatever you manufacture, you'll build a better product with Bower roller bearings. Write to Bower today. A Bower engineer will give you full details of the complete Bower line.

BOWER ROLLER BEARING COMPANY • DETROIT 14, MICHIGAN

BOWER

ROLLER BEARINGS



A COMPLETE LINE OF TAPERED, STRAIGHT AND JOURNAL ROLLER BEARINGS

Eatonite-Faced Valves

an Important Advancement in Lengthened Valve Life



Eatonite—a heat resistant, corrosion resistant, and wear resistant alloy applied to valve faces by special Eaton-developed techniques—adds materially to valve life in commercial vehicles and heavy-duty industrial engines. An important factor in the outstanding performance records being set by Eatonite-faced valves is the homogeneous structure produced by the Eaton process of applying the hard-facing material. Eatonite-faced valves come well within practical limits from the standpoint of cost; pay for themselves many times over in lengthened life span and freedom from valve trouble. Best results are obtained when Eatonite-faced valves are used in conjunction with Eaton valve seat inserts.

Eatonite-Faced Valves are available as solid valves or as hollow sodium cooled valves.

EATON MANUFACTURING COMPANY

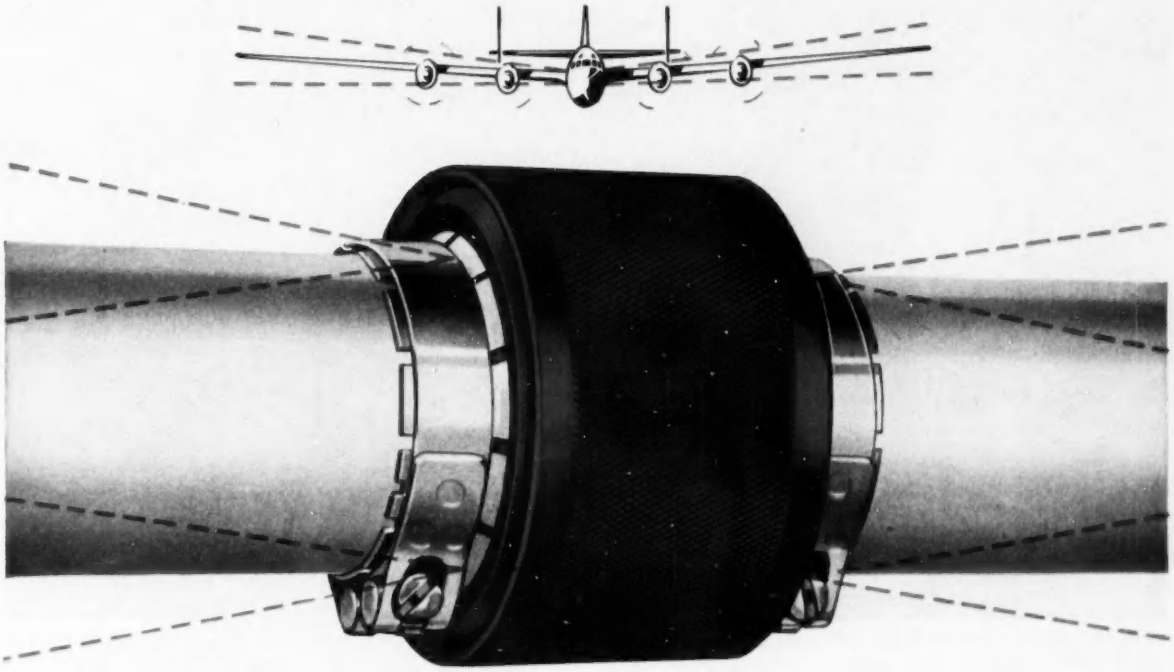
General Offices: CLEVELAND, OHIO

VALVE DIVISION: 9771 FRENCH ROAD • DETROIT 13, MICHIGAN

PRODUCTS: Sodium Cooled, Poppet, and Free Valves • Tappets • Hydraulic Valve Lifters • Valve Seat Inserts • Jet Engine Parts • Rotor Pumps • Motor Truck Axles • Permanent Mold Gray Iron Castings • Heater-Defroster Units • Snap Rings Springtites® Spring Washers® Cold Drawn Steel® Stampings® Leaf and Coil Springs® Dynamatic Drives, Brakes, Dynamometers

The Aeroquip Flex Joint

FIRST TO PERMIT SUCCESSFUL FLEXING OF RIGID FUEL LINES



Another "first" for Aeroquip! The amazing Flex Joint permits flexing of rigid fuel lines in aircraft while maintaining a positive, fluid-tight seal. Of simple, bellows-type design, the Flex Joint allows tubing to "give" 10°, plus or minus, and accommodates wing deflections, vibration, thermo-expansion, and construction tolerances. It is compact, light in weight and can be installed in confined areas without special tools . . . without precise cutting of tubing or flaring of tube ends. Extensive tests on the Flex Joint have been conducted ranging from —65° F. to +160° F., from flexing, vibrating and actuating, to testing under pressure and vacuum, and determining ultimate strength by bursting. The work has been conducted along lines laid down by the N.A.S.C. Descriptive literature is available; please write.

Aeroquip

REG. TRADE MARK

AEROQUIP CORPORATION, JACKSON, MICHIGAN

SALES OFFICES: BURBANK, CALIF. • DAYTON, OHIO • HAGERSTOWN, MD. • HIGH POINT, N. C. • MIAMI SPRINGS, FLA. MINNEAPOLIS, MINN. • PORTLAND, ORE. • WICHITA, KAN. • TORONTO, CANADA

AEROQUIP PRODUCTS ARE FULLY PROTECTED BY PATENTS IN U.S.A. AND ABROAD

OSBORN



This wheel of fortune pays 20 to 1 on every turn

In one minute this machine does a job that formerly required 30 minutes! It shows what *you* can do with new OSBORN Power Brushing techniques to speed *your* production and cut costs.

The job consists of deburring ends of stainless steel blades of a jet engine stator assembly. Chucked up in a grinder, as shown, the assembly rotates counter-clockwise at 20 rpm. An 8-inch grinding wheel grinds the ends of the vanes. Burrs and feather edges are then removed by two OSBORN 10-inch Monitor® Brushes rotating at 2800 rpm—45 seconds in each direction. The complete cycle takes 1½ minutes. Vane ends are made uniformly smooth, 20 times as fast as former hand method.

The answer to *your* production problems may be found with special Osborn-equipped machines such as this . . . or with one of the Osborn Brushing Machines which are being used in scores of plants for high-speed deburring. For *any* problem in deburring, cleaning and finishing, start tackling it with the powerful experience of your **O**sborn **B**rushing **A**nalyst. Call him or write *The Osborn Manufacturing Company, Dept. S-5, 5401 Hamilton Avenue, Cleveland 14, Ohio.*

FREE: New booklet on deburring with Osborn Power Brushing. Write for your copy.



Osborn Brushes®

OSBORN POWER, MAINTENANCE AND PAINT BRUSHES AND FOUNDRY MOLDING MACHINES



the EXTRA BRAKING CONTROL proven here...

Powerful Bendix-Westinghouse Air Brakes Provide Sure, Dependable Stops for Rugged Diesel Tankers!

Imagine this if you can. You're behind the wheel of a heavy diesel tanker headed north toward San Francisco over California's rugged coastal ranges. Here, in addition to normal hazards of the highway, you'll encounter mile after mile of steep downgrades and sharp, tight curves that at times **require maximum braking performance.** But you're prepared, on this imaginary journey of yours, because if you're anything like the men who *actually do* travel this route, you're equipped with Bendix-Westinghouse—the world's most tried and trusted air brakes. That's because these **mighty brakes,** built by the industry's most experienced manufacturer, deliver the extra stopping power and performance that assure the **safest, surest, most dependable braking control** and longest service life in the business. And these are factors that mean reliable, economical operation on any hauling job—from the roughest to the most routine! So why not give your prospective truck customers all the benefits of this superior braking performance and the savings that go with it? Specify Bendix-Westinghouse, the world's most tried and trusted air brakes!

... means GREATER RELIABILITY on any hauling job!



Bendix-Westinghouse

THE WORLD'S MOST TRIED AND TRUSTED

AIR BRAKES

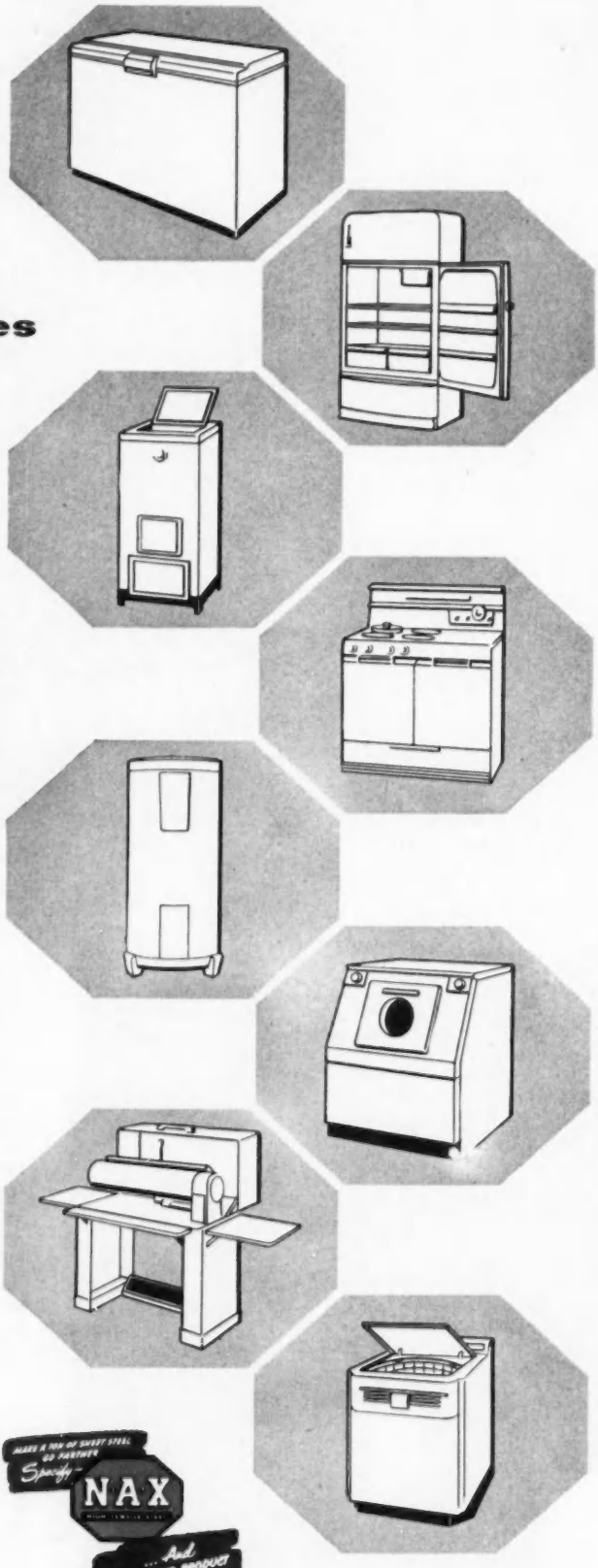
BENDIX-WESTINGHOUSE AUTOMOTIVE AIR BRAKE COMPANY • ELYRIA, OHIO • BERKELEY, CALIF.

for **High Strength** and

Longer Life in

Household Appliances

Specify



N-A-X

HIGH-TENSILE STEEL

N-A-X HIGH-TENSILE, having 50% greater strength than mild carbon steel, permits the use of thinner sections—resulting in lighter weight of products, yet with greater resistance to denting. It is a low-alloy steel—possessing much greater resistance to corrosion than mild carbon steel, with either painted or unpainted surfaces. Combined with this characteristic, it has high fatigue and toughness values and the abrasion resistance of a medium high carbon steel—resulting in longer life of products.

N-A-X HIGH-TENSILE, with its higher physical properties, can be readily formed into the most difficult stamped shapes, and its response to welding, by any method, is excellent. Due to its inherently fine grain and higher hardness, less surface preparation is required for either painted or plated parts.

Your product can be made lighter, resulting in shipping economies to consumer . . . to last longer . . . and in some cases be manufactured more economically, when made of N-A-X HIGH-TENSILE steel.

GREAT LAKES STEEL CORPORATION

N-A-X Alloy Division **Ecorse, Detroit 29, Michigan**

NATIONAL STEEL CORPORATION

MAKE A NAME OF SWEET STEEL GO PARTNER

Specify NAX

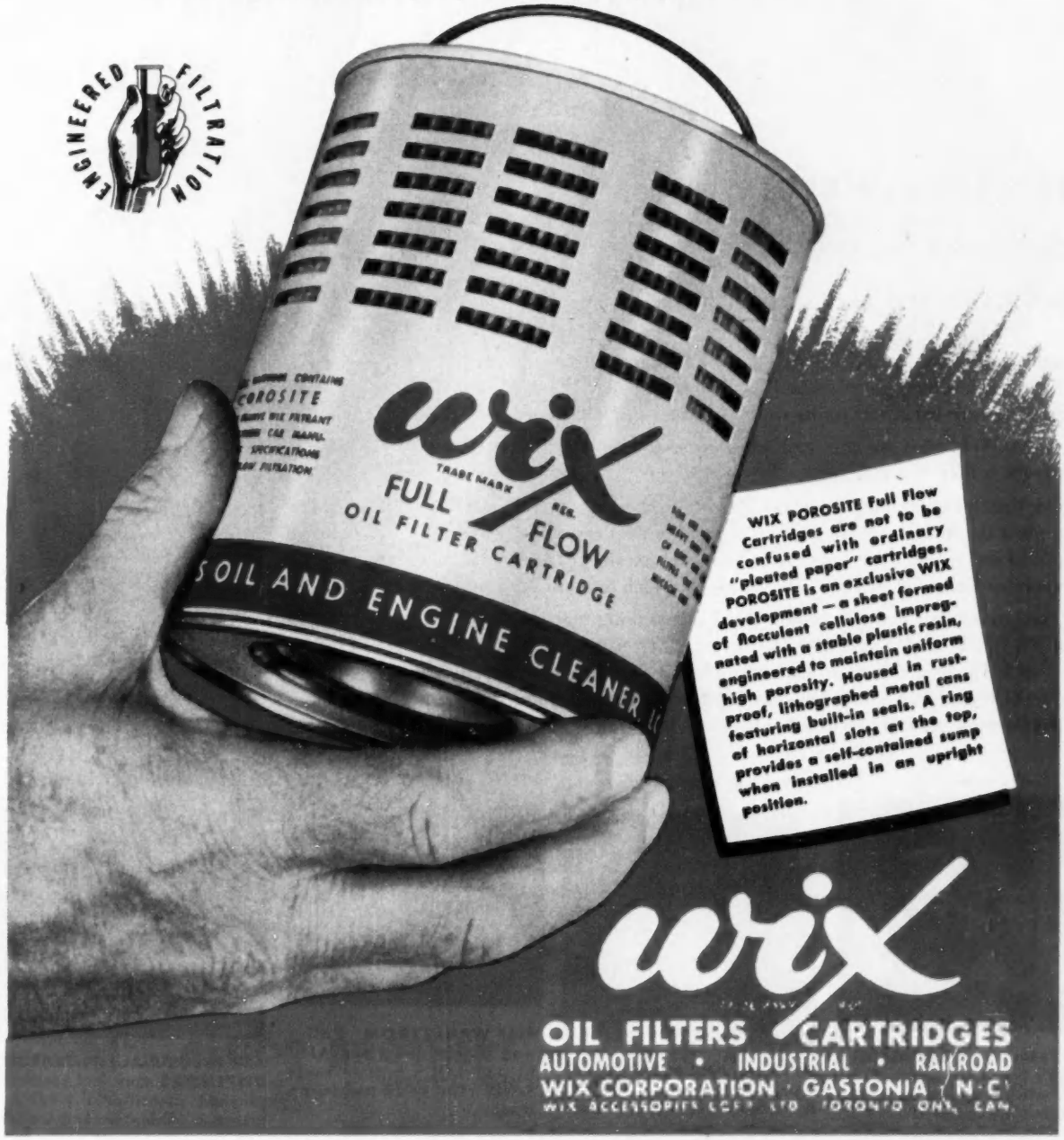
... And "MAKE YOUR PRODUCT LAST LONGER"

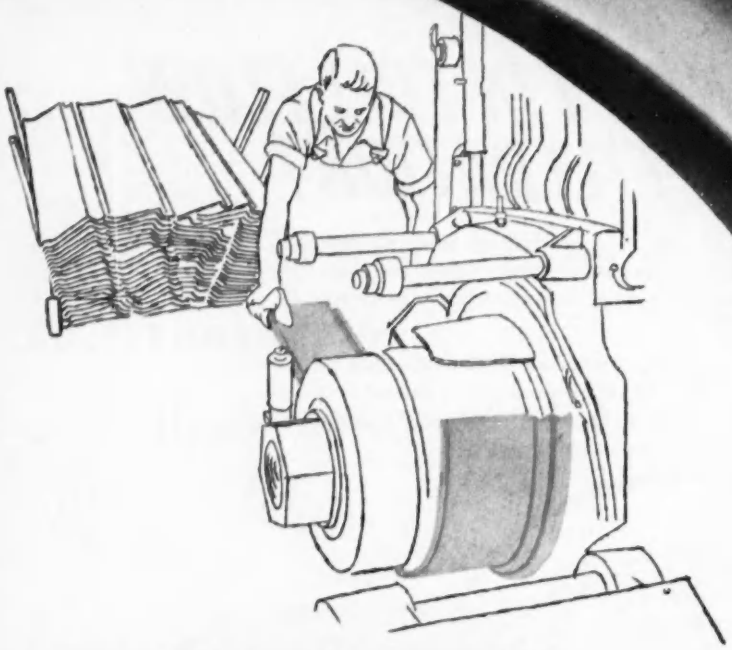
KEEP YOUR SCRAP MOVING TO YOUR DEALER

THE GREAT NEW CONCEPT IN FULL FLOW SURFACE TYPE FILTRATION!

Here's ENGINEERED FILTRATION in action . . . Full Flow, Surface Type Oil Filter Cartridges with exceptional performance characteristics. Built on prescription formulas for individual applications to equal or exceed engine manufacturers' specifications.

With years of experience in original equipment production, WIX confidently offers this great new interpretation of the full flow filtration principle to the automotive industry. Ask us to show you how these high performance POROSITE Cartridges and WIX Filters can be adapted precisely for your equipment.







AMF CLEVE-WELD* RIMS

...designed for greater safety

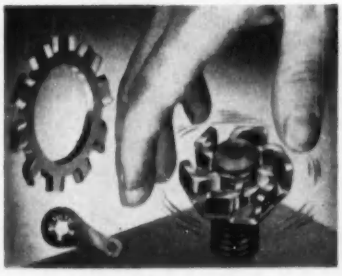
...built for greater strength

Although different makes of rims are interchangeable, they are not necessarily *alike!* Take, for instance, the added safety designed into AMF Cleve-Weld's popular 3-piece, wide-base truck and trailer rim. Its endless side flange just *can't fly off!*

AMF Cleve-Weld rims are strongest where strains are greatest. Elsewhere, their weight is held to a minimum.

For more than 40 years, The Cleveland Welding Company, an AMF subsidiary, has supplied the Automotive Industry with quality rims and spacer bands. Cleve-Weld also makes many other rolled-and-welded steel parts, such as motor and generator frames, gear rings, and bands on which to mold solid rubber tires.

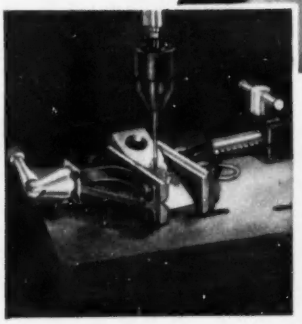
Here, then, is another example of how AMF engineering ingenuity and AMF products help the Automotive Industry turn out *better* products... *faster...at lower cost!* Others are illustrated below. Your inquiries are invited. Address: American Machine & Foundry Company, General Products Group, 511 Fifth Avenue, New York 17, N. Y.



ASSEMBLY IS SPEEDED by AMF's Thompson-Bremer *Everlock** self-locking nuts, tooth-type lock washers and SEMS.



SHIPPING AND MAINTENANCE departments find AMF De Walt* Power Saws save time in all wood-cutting operations.



AMF WAHLSTROM* Fully-Automatic Chucks and AMF FLOAT-LOCK Instant-Change Safety Vises speed tool set-up changes.



AMF INDUSTRIAL LOWERATOR* DISPENSERS store and position planned quantities of parts in process at efficient working levels.

amf products ARE BETTER...by design

AMERICAN MACHINE & FOUNDRY COMPANY

*Registered Trademark

ANOTHER POWER TRANSMISSION PROBLEM

SOLVED for SURE

with BLOOD BROTHERS drive line assemblies





Three Blood Brothers Assemblies get the power through on this Michigan TLDT-20 Truck-Crane.

Getting real "lugging ability" in soft sand *plus* fast road speeds poses many problems. For years, the builders of Michigan Truck-Cranes and Shovels have solved their power transmission problems with Blood Brothers Drive Line Assemblies.

On this tandem drive machine, three Blood Brothers Assemblies deliver maximum engine torque equally divided between the axles.

When *you're* faced with a power transmission problem, call on our engineers. Chances are, they'll help you "solve it for sure!"



BLOOD BROTHERS machine co. ALLEGAN, MICHIGAN

UNIVERSAL JOINTS AND DRIVE LINE ASSEMBLIES

A Division of Standard Steel Spring Co. • Chicago Office: 122 S. Michigan



Three reasons

why Lockheed in California

offers

better careers for engineers



This capacity to develop and produce such a wide range of aircraft is important to career-conscious engineers. It means Lockheed offers you broader scope for your ability. It means there is more opportunity for promotion with so many development and production projects constantly in motion. It means your future is not chained to any particular type of aircraft—because Lockheed is known for leadership in virtually all types of aircraft.

Lockheed's versatility in development and production is also one of the reasons it has an unequaled record of production stability year after year.

1 *Diversified Production*

Huge luxury airliners, cargo transports, fighters, bombers, trainers and radar search planes are rolling off Lockheed assembly lines. Twelve models are in production.

2 *Diversified Development Projects*

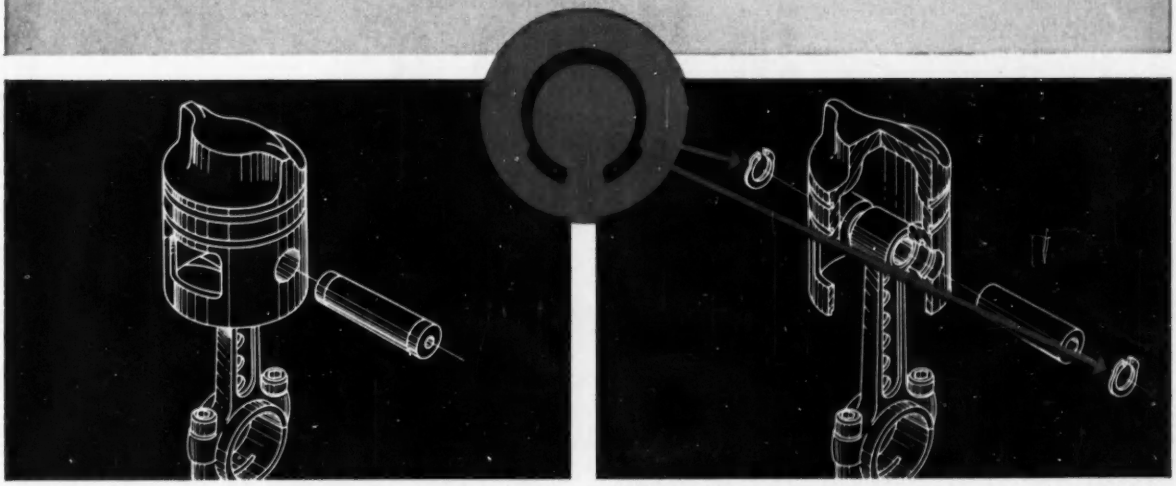
The most diversified development program in Lockheed's history is under way—and it is still growing. The many types of aircraft now in development indicate Lockheed's production in the future will be as versatile as it is today—and has been in the past.

3 *Diversified Living*

You work better in Lockheed's atmosphere of vigorous, progressive thinking—and you live better in Southern California. You enjoy life to the full in a climate beyond compare, in an area abounding in recreational opportunities for you and your family.

Lockheed AIRCRAFT CORPORATION
Burbank, California

2 Waldes Truarc Rings Replace 2 End Plugs ...Eliminate 3 Operations...Save $.066 Per Unit



OLD WAY Two inserted-plug type wrist pin locks hold wrist pin in place. 3 operations involved: costly machining, pressing in place, post-assembly machining. Costly maintenance problem—resulting from end plugs hammering loose.

TRUARC WAY Two Truarc Inverted Retaining Rings (Series 5008) hold wrist pin in place. Truarc Rings snap into grooves easily cut in piston, provide positive lock . . . practically eliminate maintenance costs. Quick assembly, disassembly.

Titan Chain Saws, Inc., Seattle, Washington, uses 2 Waldes Truarc Rings to replace old-style inserted-plug type wrist pin locks in their Titan chain saws. Use of Waldes Truarc Retaining Rings eliminates 2 press fit end plugs. Machining of plugs, pressing in place, finish machining—no longer required. Truarc way holds rejections to a minimum. Unit efficiency is greatly increased.

Redesign with Truarc Rings and you, too, will cut costs. Wherever you use machined shoulders, bolts, snap rings, cotter pins, there's a Waldes Truarc Retaining Ring designed to do a better job of holding parts together.

USE OF 2 WALDES TRUARC RINGS PERMITTED THESE SAVINGS PER UNIT:

OLD WAY	
Cost of 2 end plugs Cost of pressing in and machining	$ .169
TRUARC WAY	
Cost of grooving piston Cost of 2 Truarc Rings	.103
Saving per Unit	**$ .066**

Waldes Truarc Rings are precision-engineered . . . quick and easy to assemble and disassemble. Always circular to give a never-failing grip. They can be used over and over again.

Find out what Waldes Truarc Retaining Rings can do for you. Send your blueprints to Waldes Truarc engineers for individual attention, without obligation.

For precision internal grooving and undercutting . . . Waldes Truarc Internal Grooving Tool.



SEND FOR NEW CATALOG

WALDES

TRUARC

REG. U. S. PAT. OFF.

RETAINING RINGS

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, NEW YORK

WALDES TRUARC RETAINING RINGS AND PLIERS ARE PROTECTED BY ONE OR MORE OF THE FOLLOWING U. S. PATENTS: 2,382,947; 2,382,948; 2,414,852; 2,420,921; 2,420,341; 2,439,765; 2,441,646; 2,455,165; 2,483,390; 2,483,383; 2,487,602; 2,487,603; 2,491,308; 2,509,081 AND OTHER PATENTS PENDING.



Waldes Kohinoor, Inc., 47-16 Austel Place, L. I. C. 1, N. Y.

Please send me the new Waldes Truarc Retaining Ring catalog.

SA 095

(Please print)

Name.....

Title.....

Company.....

Business Address.....

City..... Zone..... State.....

When Are You Justified in Using a Special Alloy Steel?

Probably not more than 5 pct of all alloy-steel applications justify the use of special grades. And these relatively few cases are the ones in which the main properties sought are resistance to heat, or corrosion, or low-temperature impact. Generally speaking, there are no other advantages to be gained by using special grades of alloy steel.

In the remaining 95 pct of all applications, whether civilian or military, the standard AISI grades of alloy steel will meet the usual requirements for strength, hardness, and ductility.

There are two big advantages in using standard grades. (1) Their chemical ranges usually fall within closer limits than those of the non-standard grades. This means that standard methods of heat-treatment can be used, and the results can be predicted to a closer degree. (2) Smaller tonnages of standard grades can be bought, eliminating the need for large, costly inventories. A non-standard grade is produced and sold only in heat lots.

If you have any kind of problem concerning alloy steels, their heat-treatment or applications, you can count on our metallurgists for unbiased advice. We manufacture and sell the entire range of AISI standard grades of alloy steel, as well as special-analysis steels and carbon steels.

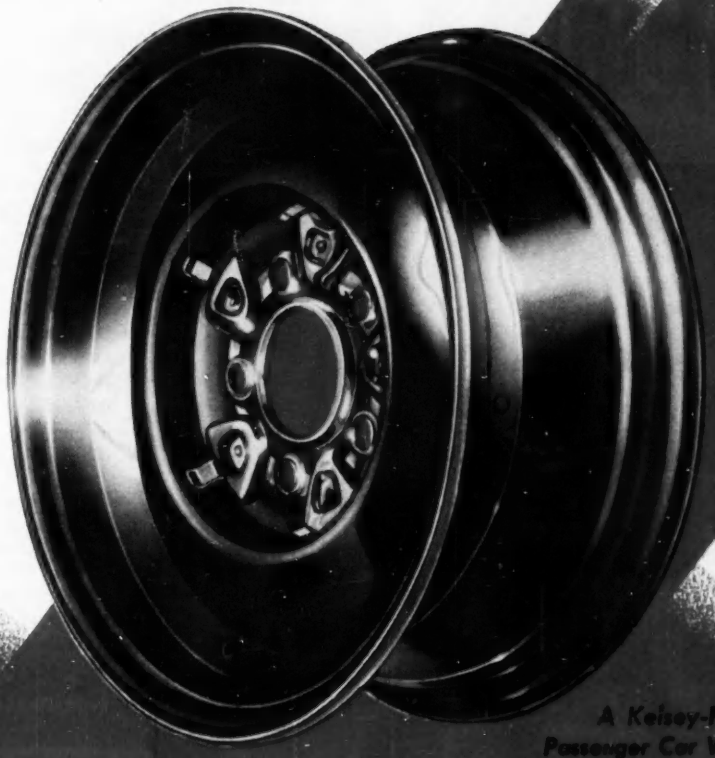
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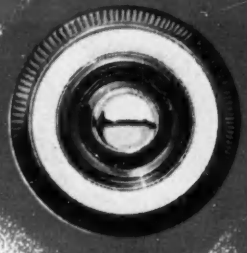
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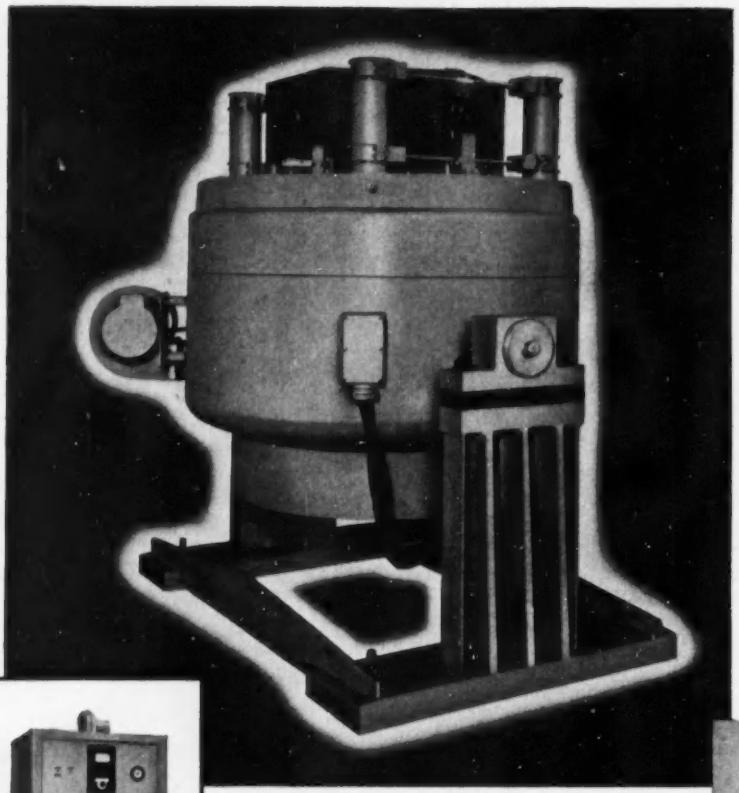
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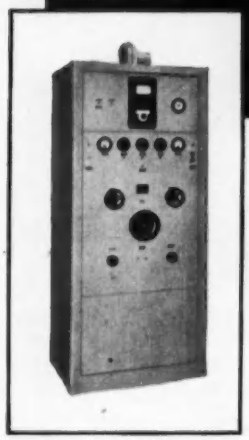
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Total output, 30,000 BTU/hr.

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powerful! compact! economical!

heater provides engine starting—cab heating—defrosting!

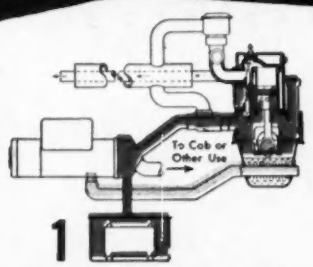
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South Wind 3-phase internal pre-heating



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Starting Phase—Heat into engine crankcase is diverted (as shown) to air induction system to elevate temperature of fuel-air mixture and promote rapid, normal combustion in chambers. Internal pre-heating of critical parts and normal lubrication frees bearings, shafts, pins and pistons from starting strain and friction wear.

Operational Phase—After easy starting, normal engine operating conditions are sustained. Now, South Wind's clean heat can be used to heat the cab, defrost windshield and supply engine induction air heat. (Note: illustration shows how normal engine induction air temperature can be sustained by engine exhaust heat exchanger.)



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fresh air output
Total output,
90,000 BTU/hr.



Model 1030
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Total output, 50,000 BTU/hr.

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South Wind

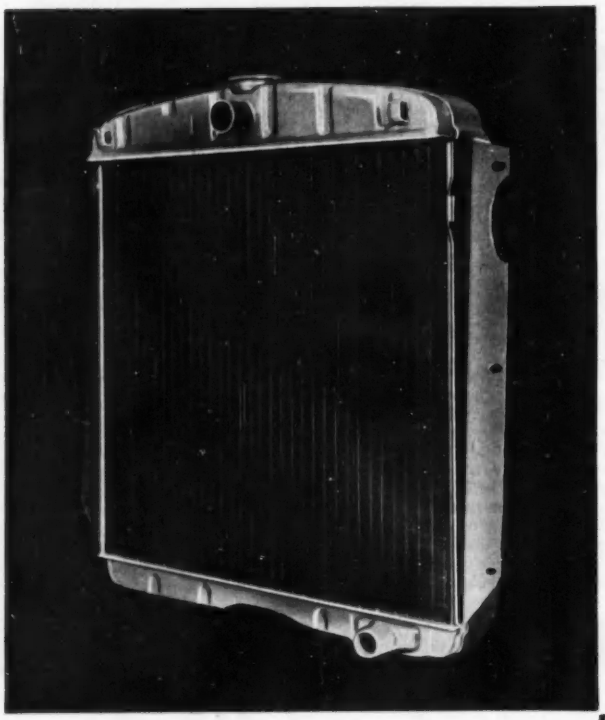
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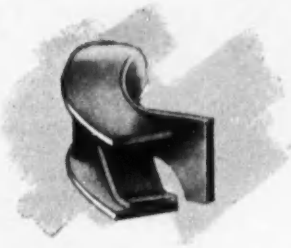




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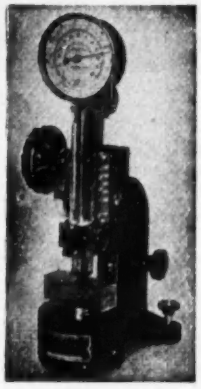
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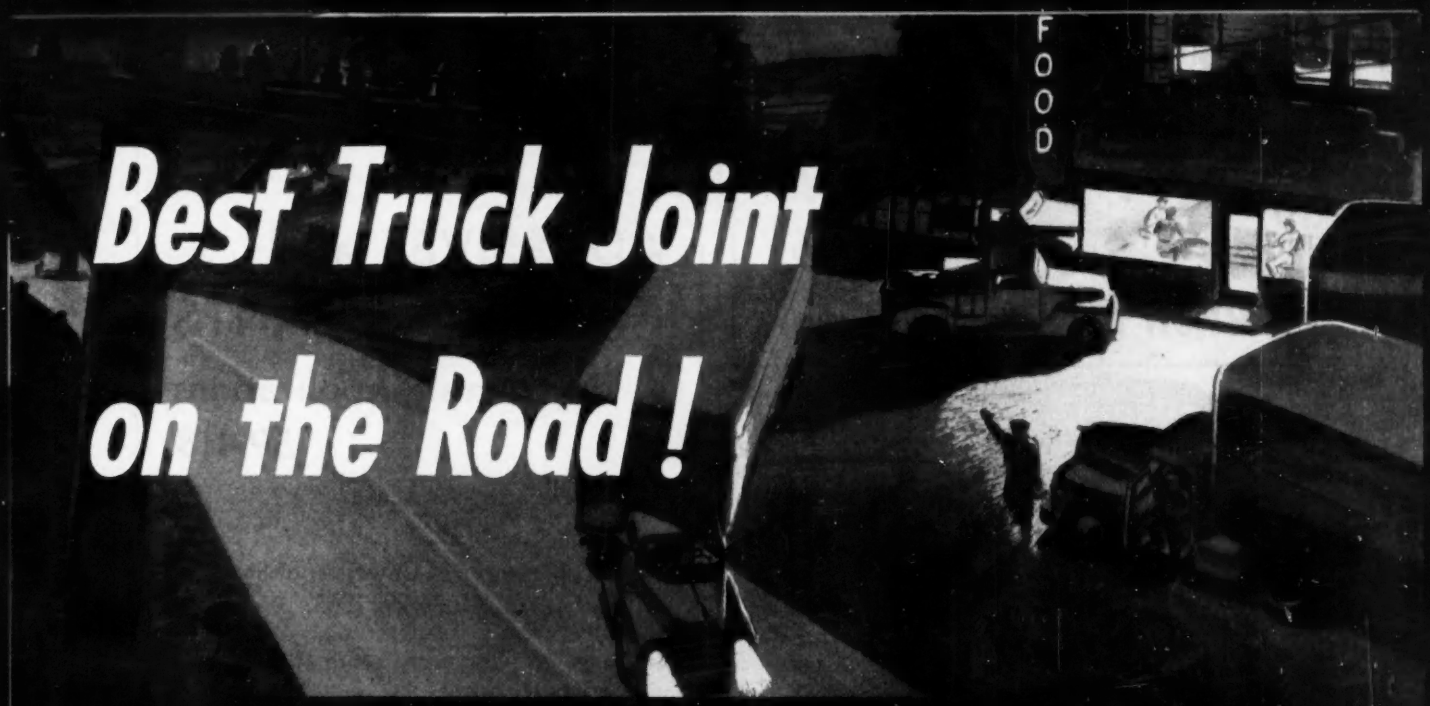
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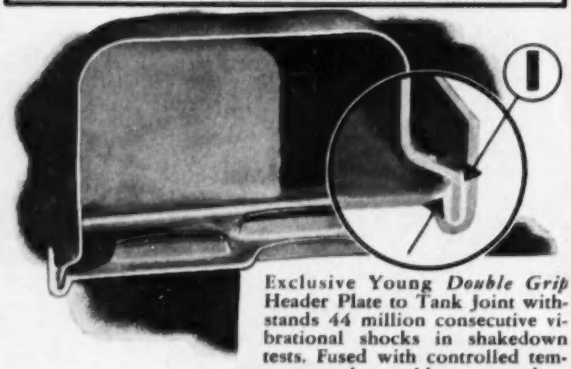
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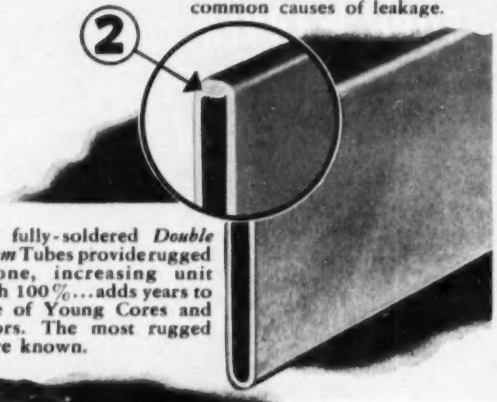
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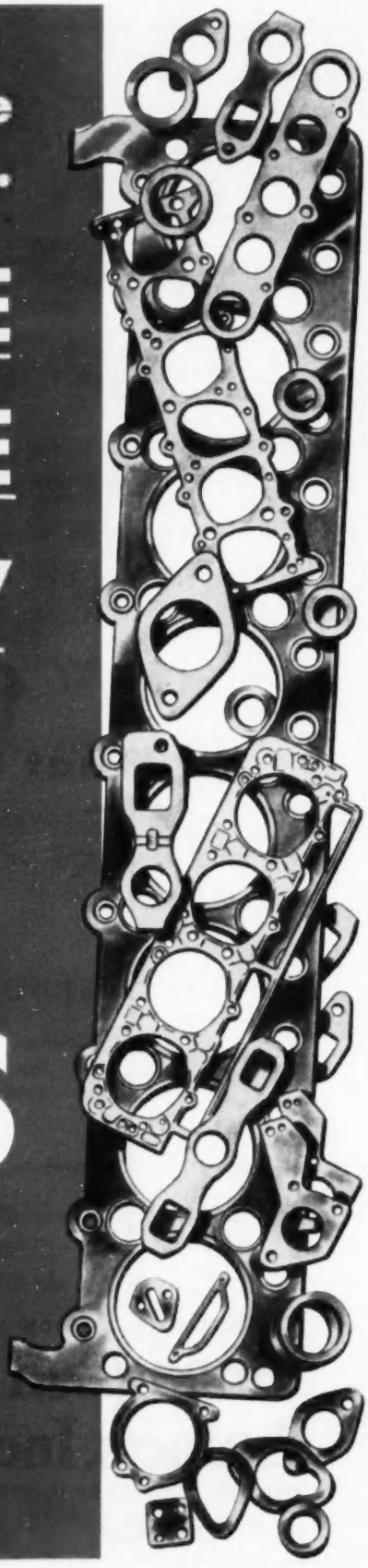
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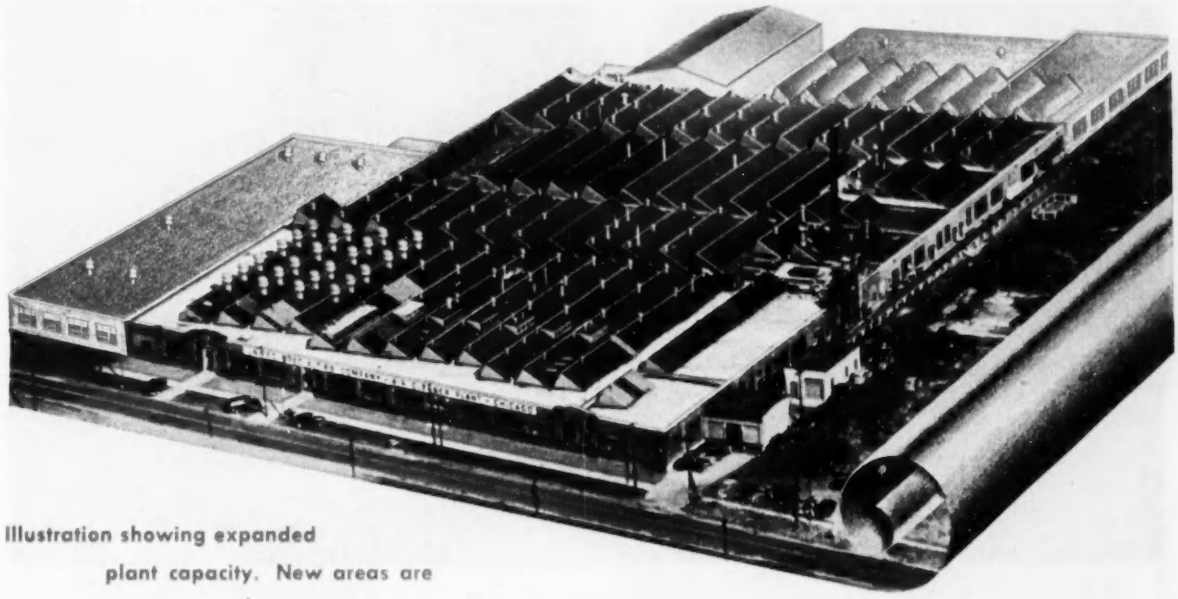


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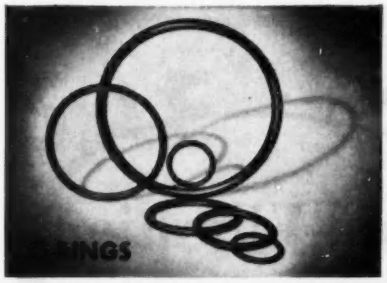
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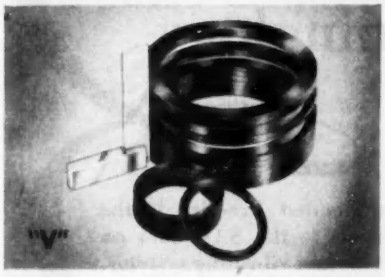
Chevrolet's chief engineer, E. N. Cole, is not only a reader of SAE Journal but an active personage in the Society of Automotive Engineers which publishes it. He has been an SAE vice-president, a vice-chairman of SAE's largest Section and a member of SAE's Publication Committee. He is also a member of the Board of the Coordinating Research Council, Inc.

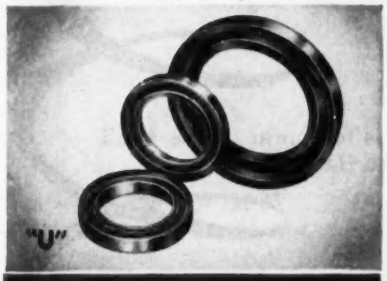
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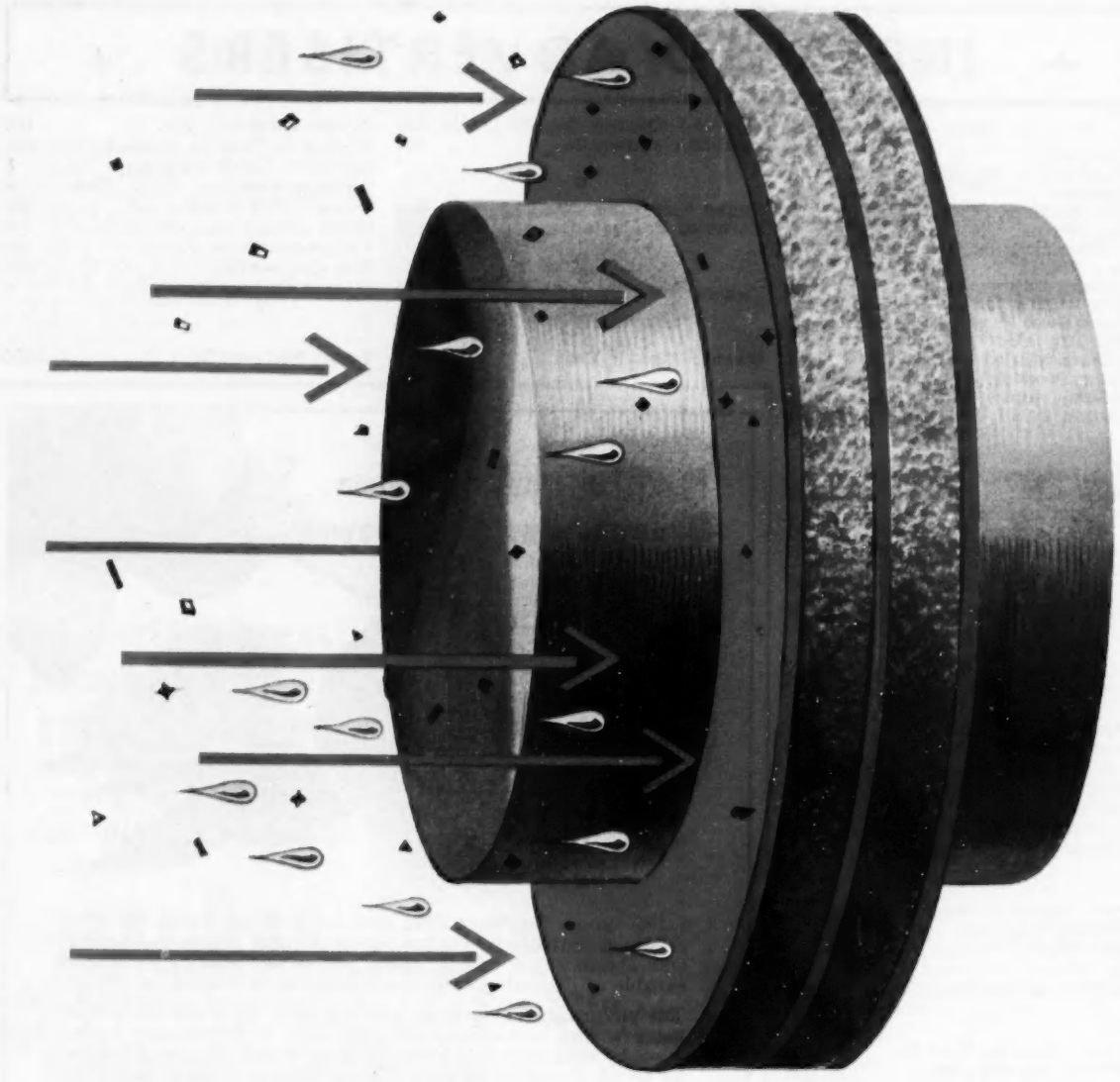
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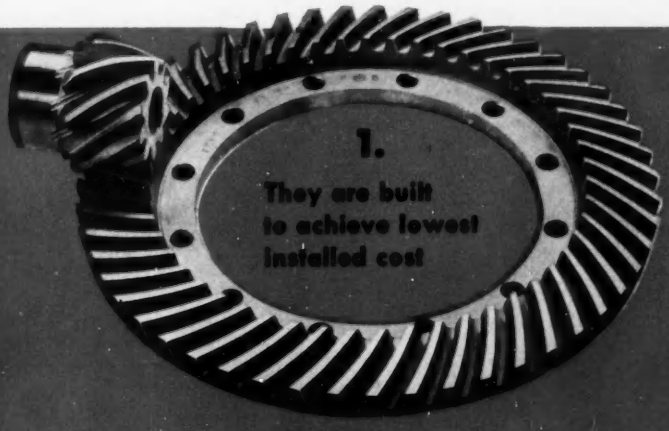
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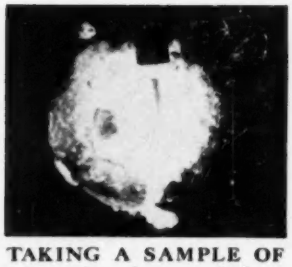
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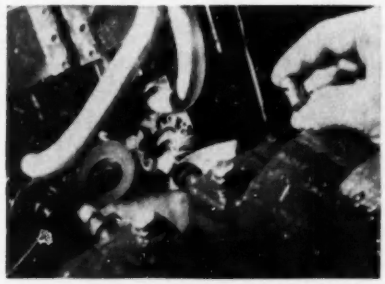
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